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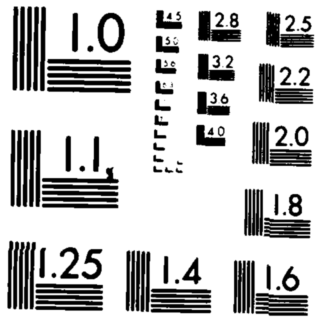

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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Omega Data Bank Report Winter 1980 through Spring 1981

Theodore Turnock

June 1983

Data Report

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US Department of Transportation
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16. Abstract

The International Bank for Airborne-Omega Data continued operation at the Federal Aviation Administration (FAA) Technical Center. This report, issued by the Data Bank, is based upon 355 flight data hours covering flights in the North and South Atlantic, parts of the Caribbean, Central and South America, Canada, and the North Pacific. These data were collected during the winter 1980 through spring 1981. There were three major contributors to the Omega Data Bank during this period operating the same equipment types.

Operationally usable signals corresponded quite well with Omega signal coverage prediction diagrams published by Omega Navigation System Operational Detail ~~(ONSOD)~~. Exceptions were noted from Ellesmere Island over the Artic Ocean for the Liberia, Hawaii, North Dakota, and Japan signals for the specific months and times of the data flights.

During the months when the above flights were made, there were 114 solar flares (of magnitude M2 or greater), 10 were coincident with recorded flight data. Several large magnetic solar flares peaked during aircraft data recording; however, no effects were discernible on observed signal-to-noise ratios (SNR's) values.

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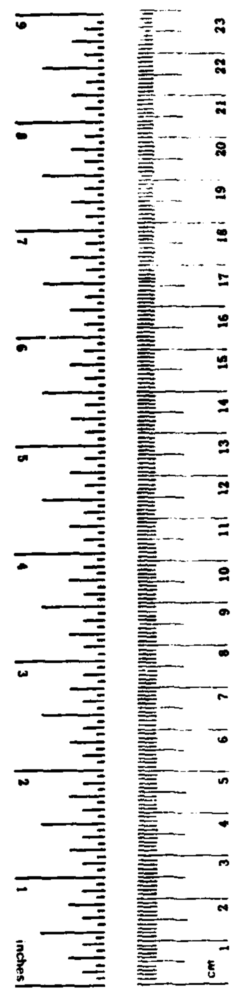
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

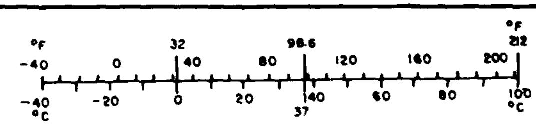


TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

INTRODUCTION

PURPOSE.

This report is the third in a series of periodic technical reports which provide a standardized data presentation of Omega signal coverage, as measured by production airborne-Omega navigation systems over routes of commercial interest under various signal environments (e.g., propagation problem regions, high solar activity). If an independent onboard position reference system was available and recorded, then Omega position differences are also presented.

BACKGROUND.

An International Bank for Airborne-Omega Data is in operation at the Federal Aviation Administration (FAA) Technical Center. This Data Bank is designed to: (1) produce empirical signal coverage charts based upon data obtained from several different airborne-Omega navigation systems over routes of commercial interest; (2) provide a measure of the range of signal-to-noise ratios (SNR's) levels obtainable for different factors which include type of Omega set, aircraft installation configuration, geographic location, seasonal changes, and effects of high solar activity; (3) help define coverage "holes" and marginal areas where certain circumstances may produce a hole; (4) examine the role that the very low frequency (VLF) option plays in those Omega Navigation Systems (ONS's) equipped to receive the United States (U.S.) Navy VLF stations as a backup to Omega; (5) provide real-world information to enhance theoretical inputs for simulation of proposed new routes; and (6) provide the capability to develop a statistical data base on Omega accuracy along world-wide air routes if contributors exercise the option to allow the recording of the Inertial Navigation System (INS) for later position comparison with the Omega data.

The Data Bank is required to handle large quantities of Omega data from various types of aircraft and from several models of Omega navigation systems. Therefore, standardization of data recording, data processing, and reporting procedures is mandatory. To optimize the efficiency of the Data Bank, the FAA Technical Center designed an airborne interface and recording set which could be easily installed and operated by commercial air carrier operators. Since the ONS data output varied among ONS manufacturers, it was necessary to specially design the interface boards for five types of ONS's. The specified design for the recording system was then furnished to Base Ten Systems Incorporated with directions to manufacture 20 cassette recorders for the Technical Center to lend to Data Bank contributors. Once a recorder is installed on a contributor's aircraft, data are collected along normal air routes and the cassette data tapes are mailed to the Technical Center for processing and analysis.

Flight data are broken down to: geographic location (648 cells as shown in figure 1), date, time of day, season, propagation path illumination, known problem regions, time correlations with both solar-geophysical events, and transmitter outages.

Data collected during each season from all contributors are analyzed and results presented in a periodic Data Bank report. The Data Bank also offers three standardized data listings and plots for individual flights. Contributors may submit written requests to obtain the listings/plots desired and/or to arrange for

special listings which best fit their needs. Details of the Data Bank structure and procedures are provided in separate reports published by the FAA Technical Center: report No. DOT-FAA-CT-80-191, "System Description for the Airborne-Omega Data Bank"; the "Initial Data Bank Report," covering fall 1978 through winter 1980, report No. DOT-FAA-CT-80-189; and the "Omega Data Bank Spring through Fall 1980," report No. DOT/FAA/CT-82-5.

DATA BANK REPORT

SUMMARY OF FLIGHT ACTIVITY.

There were three contributors for the reporting period December 1980 to May 1981. The ONS types flown were three Canadian Marconi CMA-740/CMA-771's (355 flight data hours, combined). The air routes flown include the North and South Atlantic, parts of the Caribbean to the Continential U.S., Central and South America, and Canada and the North Pacific (see figures 2 through 14, respectively). Events or regional conditions which have affected Omega reception or navigation data collected by the contributors during the reporting period are shown in table 1.

TABLE 1. REGIONS/EVENTS WHICH AFFECT OMEGA PROPAGATION

Propagation Problem Regions	Information Source
1. Greenland and Ice Cap Shadow	Westinghouse Conductivity Map
2. Antarctica Ice Cap Shadow	Westinghouse Conductivity Map
3. Nighttime Modal Interference (10.2 kilohertz (kHz))	ONSOD
4. North Auroral Zone Shadow	Davies: Ionospheric Radio
5. South Auroral Zone Shadow	Propagation, April 1965, pp. 34-35 (NBS monograph 80)
6. High VLF Noise Area	CCIR 322 publication
Events	**Information Source**
1. Solar X-Rays	NOAA "Preliminary Report and Forecast of Solar and Geophysical Data (PRF)" (weekly)
2. Polar Cap Disturbance (PCD)	ONSOD Teletypes
3. Magnetic Storm	NOAA "PRF" (weekly)
4. Station Power Reduction/Outage	ONSOD Teletype (weekly)

Note: ONSOD = Omega Navigation System Operations Detail (U.S. Coast Guard)
NOAA = National Oceanic and Atmospheric Administration
CCIR = International Radio Consultative Committee

SOLAR-GEOGRAPHICAL EVENTS COINCIDENT WITH FLIGHTS.

SOLAR-GEOGRAPHICAL EVENTS COINCIDENT WITH FLIGHTS.

The events coincident with flight times for each contributor are listed in table 2. Several Large magnitude solar flares occurred during the flights: February 26, 1981, X4; February 24, 1981, X2; May 13, 1981, X1; and May 16, 1981, X1. However, no effects were discernible insofar as system action or recorded data were concerned. The other listed events were of similar magnitude and also produced no observed or recorded effects on the contributor's ONS. An explanation of the magnitude and classification of the multiple events can be found in reference 1.

OPERATIONALLY USABLE SIGNALS.

SNR's for each Omega signal were examined from airborne data recordings to determine operational signal coverage. Usable signals are defined as those within a given cell which have SNR above threshold greater than 80 percent of the time and are deselected less than 20 percent of the time. These signals are identified on a geographic chart for each cell traversed during a flight and are compared with station coverage contours published in Omega Signal Coverage Prediction Diagrams for 10.2 kHz (reference 2). The published ONSOD prediction diagrams show the global accessibility of "usable" 10.2 kHz signals at eight fixed diurnal/seasonal times for two signal access criteria. Criterion I requires: SNR $\geq$-20 decibels (dB) (in a 100 hertz (Hz) noise bandwidth) and $\Delta\phi \leq 20$ centicycles (CEC), where $\Delta\phi$ is the modal interference induced phase deviation in the signal phase relative to the reference signal phase. Criterion II differs from Criterion I in that the SNR is $\geq$-30 dB. The eight Omega station diagrams are presented over eight selected coverage times for a total of 64 individual diagrams. Each diagram contains the SNR and $\Delta\phi$ contours for a designated signal access criterion and coverage time.

During the winter 1980-1981 and spring 1981, Contributor No. 08 followed the South America-Caribbean Sea flight route shown in figure 3. From the data recorded during these flights, two composite diagrams, one for winter and one for spring flights, are shown as figures 4 and 5, respectively.

These figures depict the Omega signals which were received with an operationally usable signal strength in each cell on the flightpath. The letter designators for each station are as follows:

- A = Norway
- B = Liberia
- C = Hawaii
- D = North Dakota
- E = La Reunion
- F = Argentina
- G = Australia (Station has been declared operational and is now usable for navigation. Trinidad station operation was discontinued on December 31, 1980.)
- H = Japan

In reviewing usable signals present in figures 4 and 5, Station E at La Reunion is shown as an example of the analysis performed to determine station performance. Both composites showed that selection of Station E above an imaginary line extending from latitude 10° S was not attempted and automatic deselection was made by the Omega computer.

TABLE 2. SOLAR-GEOPHYSICAL EVENTS COINCIDENT WITH FLIGHTS

Contributor	Date	Event	Magnitude
05	12/12/80	1	M4
	12/12/80	4	G
	12/12/80	5	W
	1/5/81	1	M5
	1/15/81	4	H
	1/15/81	5	W
	2/13/81	4	H
	2/16/81	4	H
	2/23/81	4	H
	2/23/81	5	L
	2/24/81	1	X1
	2/24/81	4	H
	2/25/81	2	1/4
	2/25/81	4	D
	2/26/81	1	X4
	2/26/81	2	1/4
	2/26/81	3	6
	3/10/81	4	F
	3/23/81	4	F
	4/1/81	1	M4
	4/1/81	3	6
	4/1/81	4	H
	4/8/81	1	H
	4/8/81	4	M5
	4/8/81	4	H
08	2/24/81	1	X2,M3
	2/24/81	5	L
	2/25/81	2	1/4
	2/25/81	3	7
	2/26/81	2	1/4
	2/26/81	3	6
	3/5/81	3	6
	3/7/81	1	M2
	3/7/81	3	6
	3/14/81	3	9
	3/14/81	4	7
	5/13/81	1	X1
	5/13/81	4	F
	5/13/81	5	1
	5/16/81	1	X1
	5/16/81	3	7
	5/16/81	4	H
	5/18/81	3	7,8,8
	5/19/81	5	L
	5/23/81	3	6

The La Reunion (E) prediction diagrams (figure 7) show a $\Delta\phi$ contour envelope which encompasses most of the upper part of South America. The primary reason for automatic deselection was unacceptable $\Delta\phi$, where the SNR was greater than -30 dB in more than 70 percent of the cells flown. Analysis of this type was performed to verify the cell coverage of other stations.

Further signal analysis of figure 4, winter 1980 flights, indicates that the Omega set used by Contributor 08 consistently received Stations A, C, D, and F in all cells, and Station H in cell numbers 348, 349, 385, 386, 422, and 423.

Station G (Trinidad) was on the air until December 31, 1981, however, this set did not select its transmissions for navigational use.

Station B (Liberia) was automatically deselected by the equipment during this time period. The prediction diagram indicated that the SNR was in the acceptable region, but outside the 20 CEC boundary. The predicted region for modal interference extends east of the station (being coincident with the geometric equator) extending into the northwestern and southeastern quadrant areas with respect to the station (see figure 9b). The modal interference was the main cause for deselection.

Station H (above the equator) was received in cell numbers 423, 422, 386, 385, 349, and 348. The coverage prediction diagram for this station shows that the S/N contour was in the -20 dB region with the $\Delta\phi$ being acceptable. Flight data indicated good correlation with the ONSOD coverage prediction diagram for a -20 dB receiver. The deselection of Station H below latitude 0° (equator) in cell numbers 312, 276, 275, and 239 show the SNR level was in the -30 dB region, with $\Delta\phi$ in the nonacceptable region off the coast of South America encompassing cell numbers 239, 275, and portions of 276. This Omega set was somewhat conservative and deselected after its transition below the equator.

Figure 5 shows the composite data for spring 1981 flights from Rio de Janerio, Brazil, to Miami, Florida, by Contributor 08 following the same route structure. Reception closely resembles the previous winter 1980-1981 composite. The letter V, shown in figure 5, indicates the VLF option was used during the flight from Miami, Florida. The VLF signal used was introduced into the position resolution process during the flight through cell 386 at 0200 Greenwich mean time (GMT). This addition of the VLF option on the Omega set provided more complete coverage capability. It was activated through cell numbers 385, 349, 348, 312, 274, and 239 until flight termination at Rio de Janerio.

The letter designators used for all VLF stations are as follows:

S - Australia
J - Japan
Y - England
M - Maine (USA)
L - Hawaii (USA)
P - Annapolis, Maryland (USA)
W - Washington State (USA)

The VLF stations received for position processing were: M, L, P, and W.

The ONS will continuously estimate position error on the basis of signal quality and line-of-position geometry. Normal error values range between 1.0 and 1.5 nautical miles, should this estimate increase to 2.0 or more nautical miles as a result of Omega signal degradation, then the VLF function is brought into the system to supplement the position determination.

The coverage diagram for the cells and two digit numbers inclusive, shown in figure 6, represent the GMT hours for the flight which were flown over a 2-day segment.

This flight made by Contributor 08 during May 2-3, 1981, followed a southerly flight route out of Mexico City to Rio De Janerio and, eventually, on to Buenos Aires, Argentina.

Station B (Liberia) was deselected in all cells above Latitude 20° S. This compares favorably with figures 4 and 5 (winter-spring) data. Comparing against the signal coverage prediction diagram for this station, the SNR of -30 dB was superimposed over the path flown from Mexico City to cell number 349. The remaining cells SNR lie in the -20 dB contour.

The $\Delta\phi$ throughout the total flight route exceeded the 20 CEC value, which negated usage of Station B. This contributor set deselected to protect against modal interference.

The only exception was the reception of Station B during the hours after 1100 GMT in cell numbers 239, 240, and 204. The prediction diagram indicates Station B with a SNR at -20 dB also had a favorable $\Delta\phi$ of $\leq$20 CEC during this time period.

Station A signal reception during departure from Mexico City presented marginal signal due to the shadow effect by Greenland. This station was deselected in cell number 388 momentarily, reselected during transition through cell 387, and locked into the equipment until landing at Rio De Janerio.

Station E (La Reunion) was not received in any of the cells flown. ONSOD coverage prediction diagram for both 0600 GMT and 1800 GMT indicates that the SNR was beyond the -30 dB boundary and the $\Delta\phi$ greater than 20 CEC for all cells above a line extending through latitude 10° S. The cells numbers affected were 388, 387, 350, 349, 313, 312, and portions of 276. All other cells were in the acceptable region for a -30 dB receiver, but were not selected by the Omega set.

An SNR of -20 dB (in a 100 Hz bandwidth) has been considered the threshold for usable Omega signals. With the introduction of new technology receivers, this lower value has been extended to -30 dB as a more realistic value.

Deficiency of Station H (Japan) in cell numbers 313, 312, 276, 275, 240, and 239 can be explained by the prediction diagram indicating an SNR $\geq$-30 dB outside the boundary; the equipment deselected automatically.

South America to Europe flights, made by Contributor 08 during the winter 1980-1981 and spring 1981, followed the route shown in figure 3. Flight data were recorded from 0100 through 1100 GMT. Usable signals are presented in composite figures 8 and 9.

In figure 8, cell numbers 239, 274, 275, 310, 345, 346, 381, 417, 416, 452, and 487 consistently received Omega signals from stations A, C, D, E, and F.

Stations deselected were B and H in cells below latitude 20° N bracketed between longitude 0° W through 30° W. Correspondence were verified with prediction diagrams for Station B where was beyond limits, and for station H where the SNR was greater than -30 dB through all cells below the same latitude.

Omega coverage was generally consistent with the ONSOD coverage diagram, and the Omega set computer chose deselection as protection against marginal signals for these stations.

Composite of figure 9 for the spring 1981 route from South America to Europe indicates Station A (Norway) was received in all cells throughout the flightpaths flown.

Station B (Liberia) was deselected in cell numbers 276, 310, 311, 345, 346, and 382 to protect against the modal interference which extends outward and east of the station during the spring (see shaded area in figure 10). Normal usable station coverage was found in cell numbers 381, 417, 418, 452, 451, and 487. The remaining cell numbers 274, 275, and 239 were on the border line for being considered unusable when comparing SNR and $\Delta\phi$.

Stations C and D were usable in all cells flown except for Station C being deselected in cell number 487.

Station E (La Reunion) was deselected in cell numbers 311, 276, and 382. The prediction diagram (see figure 7) verifies that $\Delta\phi \leq 20$ CEC boundary extended midway between South America along 0° latitude, which caused the Omega set to deselect. The asterisk (station usability dependent upon time of day) marking the remaining cells of Station E are due to the $\Delta\phi$ contour which was expanding in an ever increasing contour line from 0600 GMT. This eventually covered the entire flight route flown. Diurnal effects are not linear and interpolating for times other than what is published requires that extreme care be used.

Station F (Argentina) exhibited strong correlation with the prediction diagram where a signal was received in all cells flown. Station H (Japan) was automatically deselected by the equipment in cell numbers 239, 274, 275, 276, 310, 311, 345, 346, 381, and 382. This northern hemispheric station exhibits a region of modal interference in the southwestern quadrant covering a large area of South America and the Atlantic Ocean (reference 3). The flightpath above latitude 15° between longitude 15° and 45° W show signal reception in cells 417, 416, 452, 451, and 487. Stations marked with an asterisk were not usable all of the time because the -30 dB coverage contour passed through the cell which varied with the time of day.

Canada - Greenland flights, made by Contributor 05 during the winter-spring 1981, followed the flightpath shown in figure 11.

The Omega set used was equipped with VLF backup. Cells in which VLF was sometimes used to supplement Omega are marked with V and are shown in figures 12 and 13. It is noted that the Omega set reverted to the VLF mode whenever the SNR number for Station A (Norway) was low, between 1900 and 0800 (Greenland night); or whenever SNR for Station H (Japan) was low, between 0800 and 1900 GMT.

The operationally usable signal chart (figure 12) shows that the Omega set 03 received Stations A, C, D, F, and H with good correlation being obtained when comparing the results with the ONSOD coverage prediction diagrams. In addition, Station A coverage in cell numbers 530, 531, 533, and 494 were affected by shadowing of the Greenland Ice Cap.

Deselection of Station B occurred in cell numbers 569, 570, 571, 572, 533, 605, and 606, all cells being West of longitude 100°. Deselection was generally consistent with the prediction as compared with the coverage diagrams, and usually was due to above threshold SNR or $\Delta\phi$ values that exceeded the limiting phase deviation criteria.

Station C, D, and H, showed strong signal coverage in all cells flown. No indication of modal interference from Station D (North Dakota) was found in cell numbers 532, 533, or 495 that were in the "near-field" region ($\cong$500 to 600 kilometers (km)) radius of the station (reference 3).

Station E (La Reunion) deselection in all cells except 605, 571, and 572 is, again reinforced by reviewing the appropriate predictions chart (see figure 7); $\Delta\phi$ region of influence extended from latitude 40° N on the La Reunion Feb 0600 GMT chart, expanding upward to 79° N on the 1800 GMT coverage chart.

Station F, depending on time of day, indicated above normal values for $\Delta\phi$ in all cells west of longitude 100° during night transmissions. In addition, SNR's $\geq$30 dB prevented adequate reception above latitude 60° N, as shown in figure 12. The only exception was reception of Station F in cell numbers 565 and 571.

Station G was not considered in the analysis, one flight occurring on December 12, 1980, was auto-deselected by the equipment. Station H had usable signals for all cells flown, which was verified by the ONSOD coverage diagram.

The operationally usable signal chart (figure 13) shows no reception of Station A in cell numbers 531, 570, 569, 568, 605, and 603. This signal absence should also have included cell numbers 567, 532, and 495,which were enclosed by the boundary envelope SNR $\geq$-30 dB through mid-Canada. Possibly, this Omega set selected levels slightly above threshold for processing verification. The VLF mode was not activated in those cells.

Station B coverage was as predicted, with sporadic coverage in cells east of longitude 90° W bounded by latitude 70° N. Deselection was complete above 70° N, which corresponded with the -30 dB contour coverage diagram.

Comparing signal coverage prediction diagram for Stations C, D, and H against the flight data recorded, the SNR of -20 dB contour superimposes over the flightpath flown for acceptable signal reception. Station E (La Reunion) was deselected completely throughout Canada. The coverage prediction diagram indicates that $\Delta\phi \leq 20$ CEC for Station E was exceeded. This accounted for the deselection software to be activated in the Omega set. Station G was not operational during this period.

There were two stations that were deselected, Station F's signal above latitude 60° N was not received, the prediction diagram verifies an SNR $\leq$-30 dB range for this location; Station C's signal in cell numbers 602, 603, and 627 through 638 should also have been processed as an acceptable signal, but were deselected.

Data recorded outbound above latitude 80° N from Alert, Ellesmere Island over the Arctic Ocean, shows that Station A (Norway) was received consistently. Reception was intermittent for Stations C, D, and H with constant Omega receiver recycling through a dead reckoning (DR) mode of operation. Station B was completely deselected throughout the Arctic flight. VLF backup was used to supplement Omega through cell numbers 636 through 632, inclusive.

Limited flights by Contributor 09 over the North Pacific Ocean were flown, as shown in figure 14. Data were recorded from 1800 through 2200 GMT, with usable signal coverage of cells presented in figure 15.

Stations A, B, C, D, E, and H were received in cell numbers 364, 400, and 437 during the flight from Guam to Tokyo, Japan.

Coverage prediction diagrams (figure 16) for A, B, E, and H indicate the SNR at -20 dB. The signal for Stations C and D in cell number 364 fell within the $\geq$30 dB boundary.

The factor for deselection of Station F was modal interference where $\Delta\phi \leq 20$ CEC was exceeded in all cells enclosed by the contour envelope. The software sensing the excessive phase value, proceeded to deselect the station from further signal processing.

Reviewing a listing of the processed contributor data, a snapshot of cell number 400 from 1919 to 2007 GMT is shown in figure 17. The received SNR's for Omega Stations A through H for three primary frequencies of 10.2, 13.6, and 11.3 kHz are shown.

An explanation of the SNR numerical values between 0 and 9 represents relative SNR values for eight consecutive numerical digits for Stations A through H on each frequency.

The SNR number for that particular station (A through H) will show the strongest signals pegged at 9; marginal signals will show relatively low SNR values. It should be noted that the SNR values presented here are not directly comparable among different types of ONS; the SNR values are provided for relative comparisons between stations and frequencies received by the particular ONS operated by a contributor.

The numerical SNR values 8 or 9 appear for Stations A, B, E, and H in the assigned vertical column indicating a maximum signal received during this flight period. This sample was compared against the total number of samples in each cell to determine usability. When a station was above threshold 80 percent of the time, the station was declared usable in the cell.

A signal value of 0 or 1 represents a marginal or nonoperational station, which usually was deselected by the Omega set software. An example can be found in reviewing column G, where transmissions were terminated on December 31, 1980. An additional explanation regarding these data can be found in reference 4.

COMMENTS.

1. This third report issued by the Data Bank is based upon 355 hours of data collected during the period from winter 1980 through spring 1981. During the

months when these flights were made, there were 114 solar flares (of magnitude M2 or greater), but only 10 were coincident with recorded flight data, which had no significant effect on observed SNR values.

2. Operationally usable Omega signals derived from the contributor data corresponded quite well with the Omega signal coverage prediction diagrams published by ONSOD. Loss of reception of certain signals due to time of day or to seasonal variations are coincident with predictions in most instances.

3. Exceptions to the prediction diagrams were noted for Station E (La Reunion) near the coast of Brazil (cells 274, 310, and 346) during flights by Contributor 08. The prediction diagram indicated a -20 dB contour and favorable $\Delta\phi$ during the daylight hours, although equipment deselected Station E.

4. Another exception was noted on Contributor 05 flights over Canada's Northwest Territories. Station C (Hawaii) should have been received in cell numbers 602 and 603 and was not. The signal from Station C is predicted to be usable throughout the area flown for all times of the year.

5. Station B (Liberia) SNR was usually above signal level 7 throughout most of the flight in South America in cell numbers 239, 274, 310, 346, and 345. Automatic deselection by Omega set software protected against modal interference, with Omega set reselection occurring during the early morning hours.

REFERENCES

1. Rzonca, Lorraine, Initial Data Bank Report (Fall 1978; Winter/Spring/Summer/Fall 1979; Winter 1980), FAA-RD-80-83/FAA-CT-80-189, FAA Technical Center, July 1980.

2. Gupta, R. R., Donnelly, S. F. Creamer, P. M. and Sayer, S., Omega Signal Coverage Prediction Diagrams for 10.2 kHz, Volume II, Individual Station Diagrams, The Analytic Sciences Corp., TR-3037-2, October 1980.

3. Campbell, L. W., Servaes, T. M., Dr., and Grassler, E. R., Omega Validation in the North Atlantic, Analytical Systems Engineering Corporation, Burlington, Mass., August 1980.

4. Rzonca, Lorraine, System Description for the Airborne Omega Data Bank, FAA-RD-80-84/FAA-CT-80-191, FAA Technical Center, July 1980.

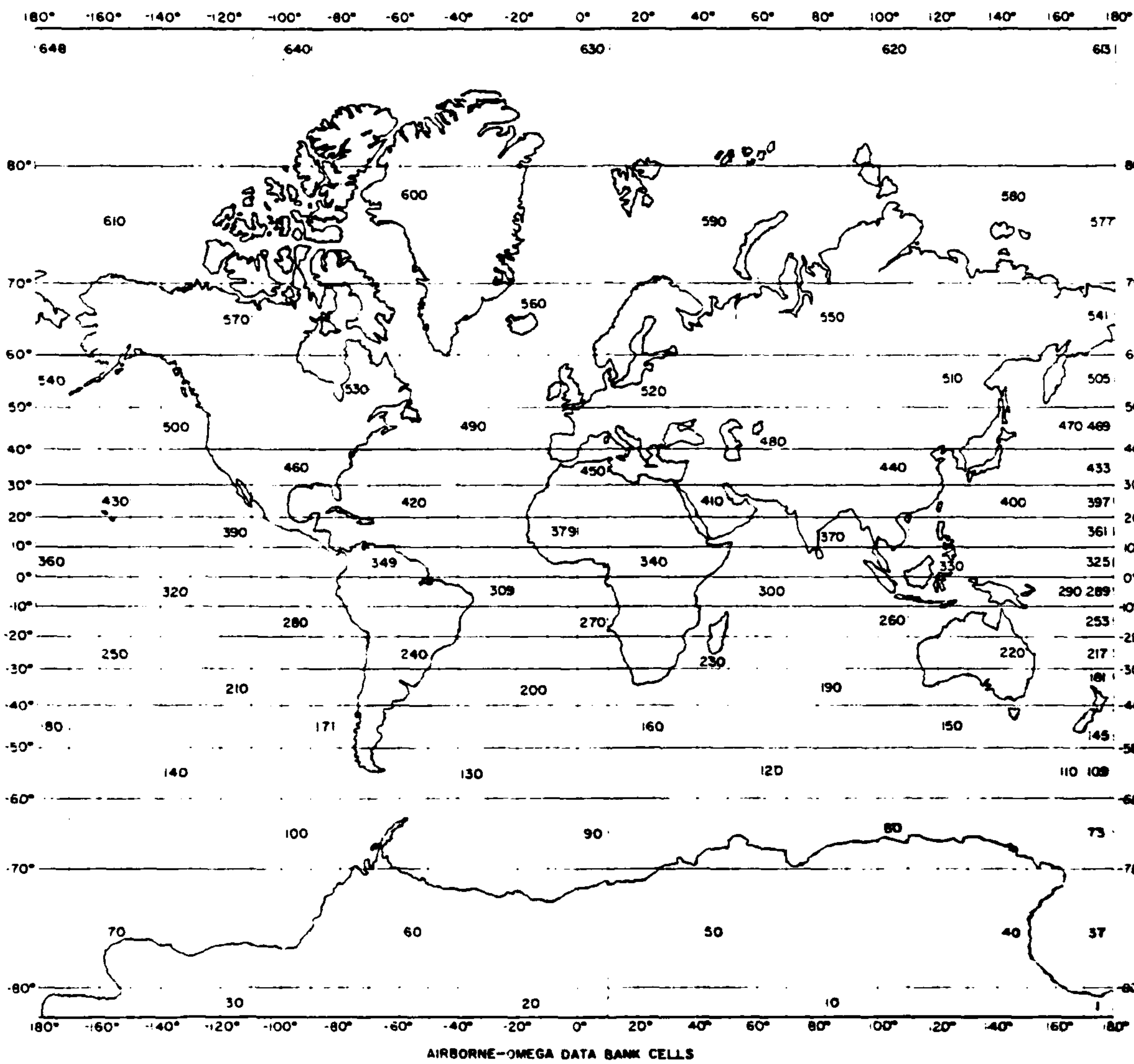


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FIGURE 1. AIRBORNE–OMEGA DATA BANK CELLS

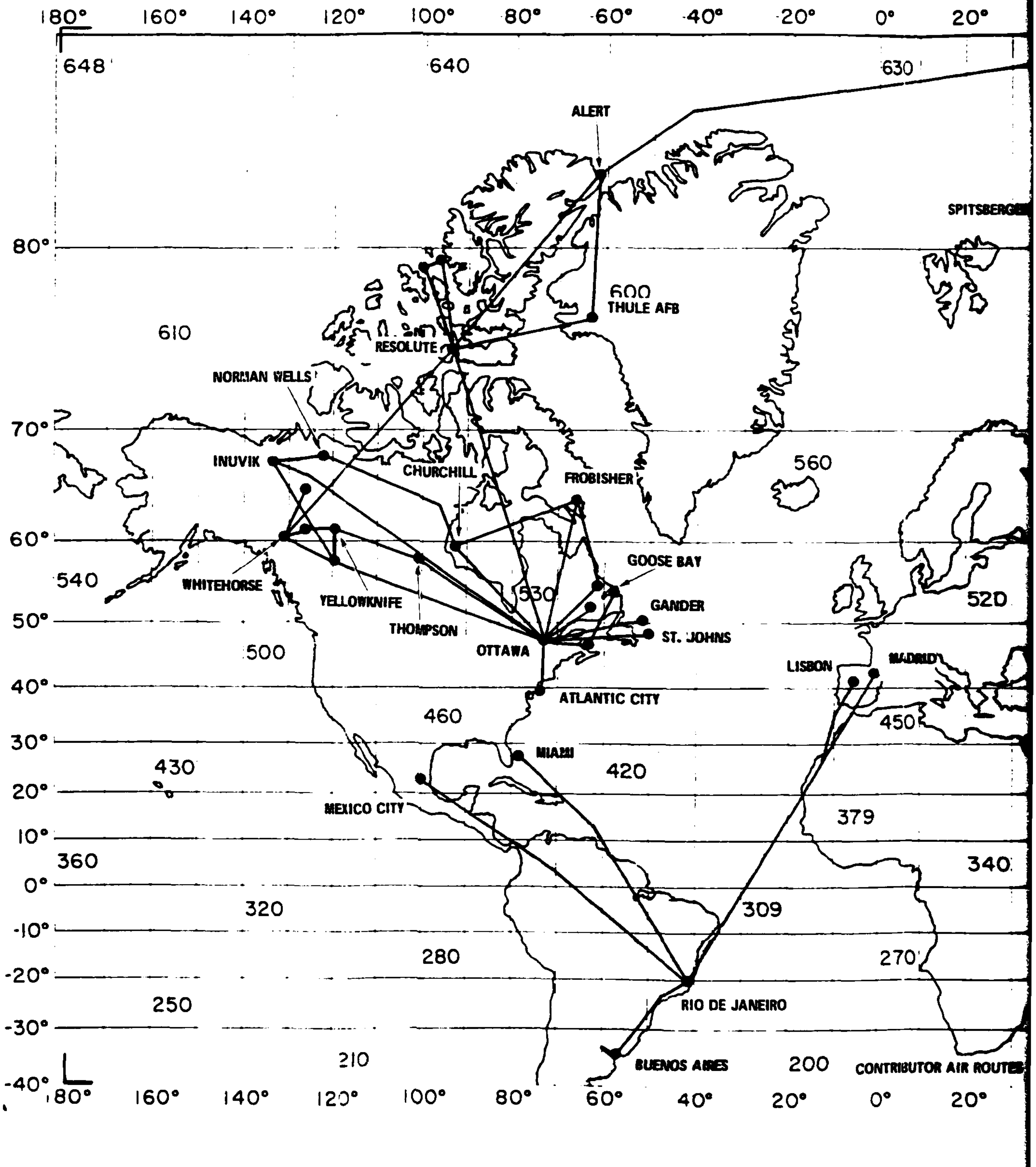
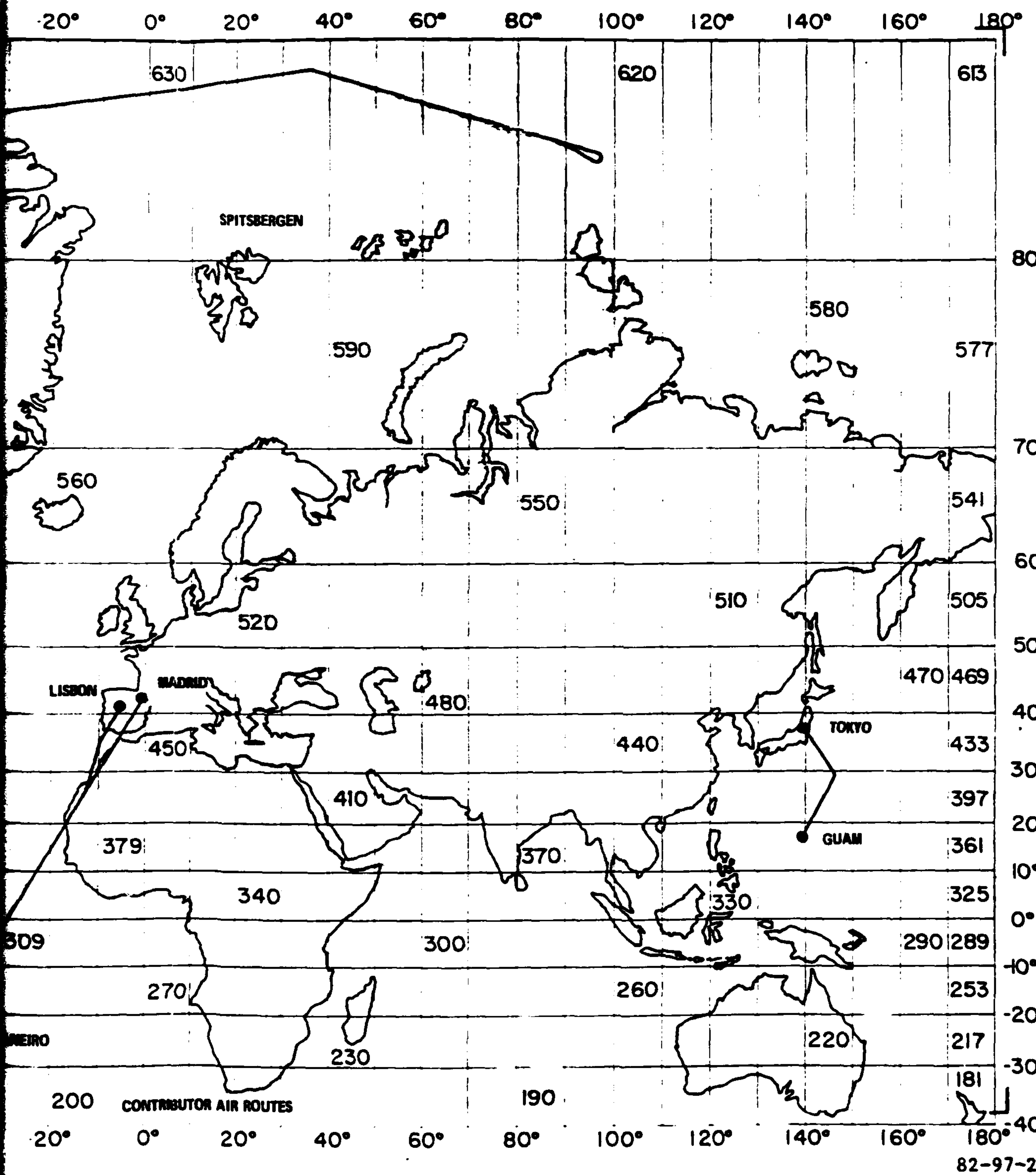


FIGURE 2. CONTRIBUTOR AIR RO



RE 2. CONTRIBUTOR AIR ROUTES

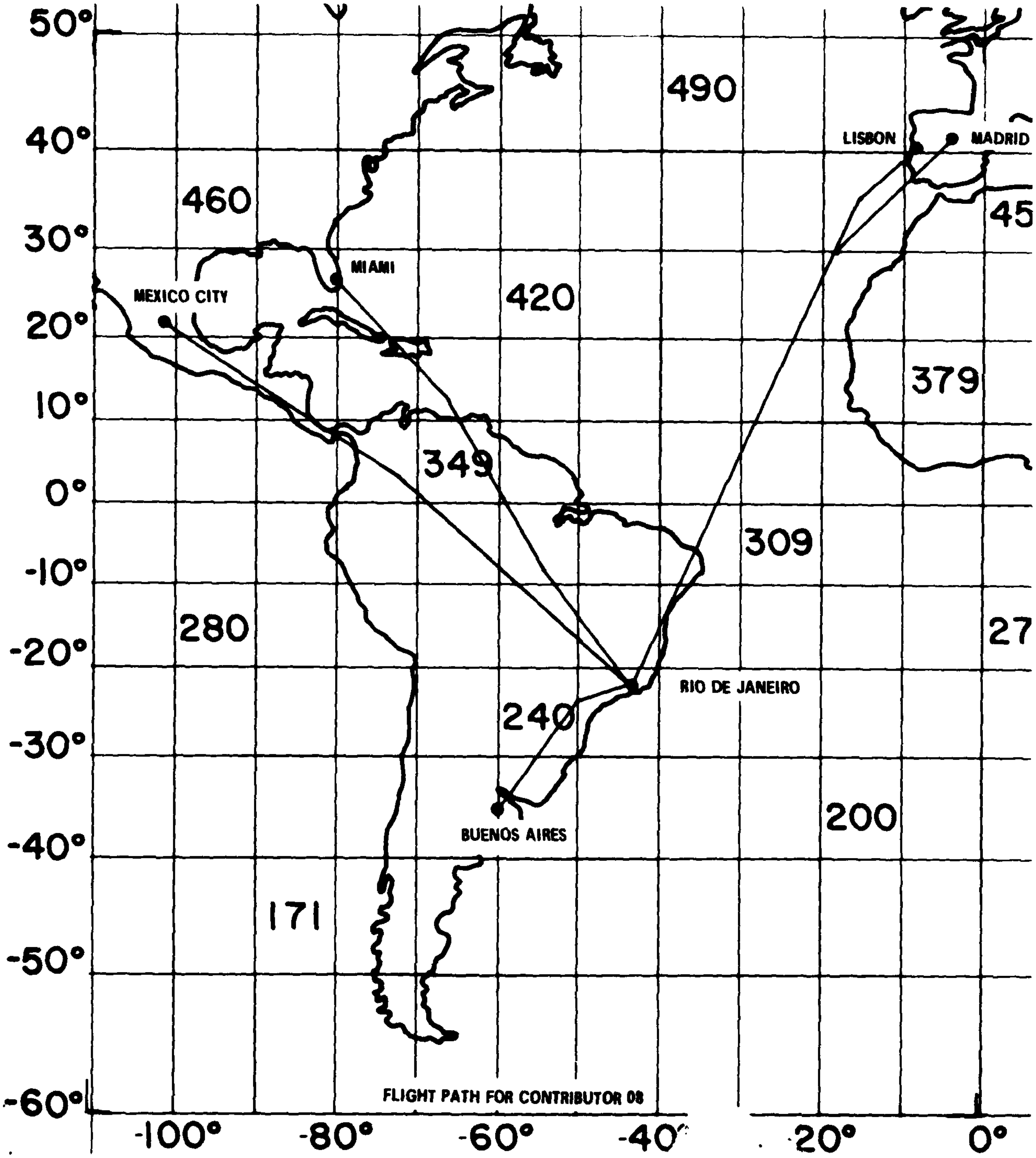


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FIGURE 3. FLIGHTPATH FOR CONTRIBUTOR NO. 08, WINTER 1980 THROUGH SPRING 1981

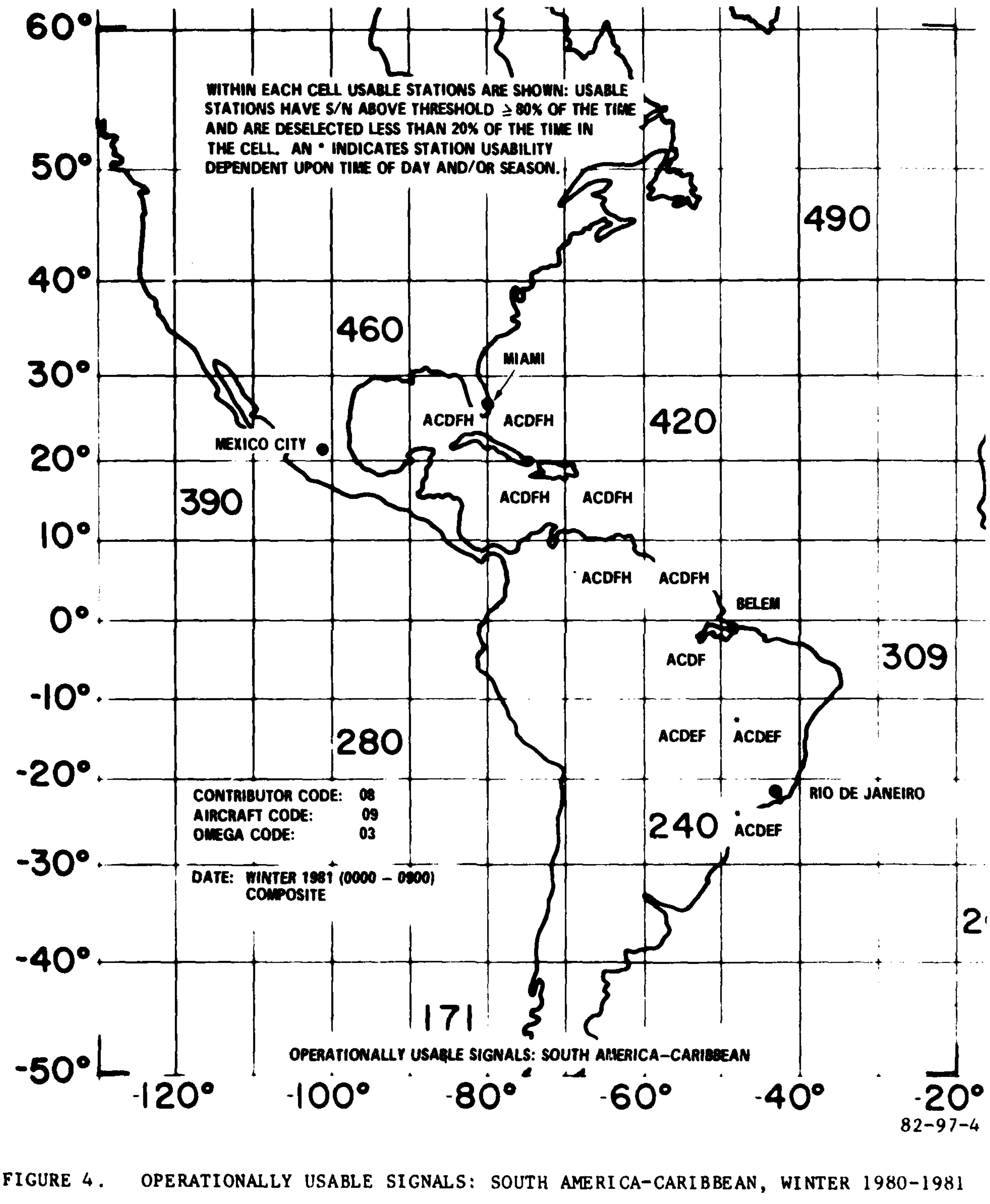

FIGURE 4. OPERATIONALLY USABLE SIGNALS: SOUTH AMERICA-CARIBBEAN, WINTER 1980-1981

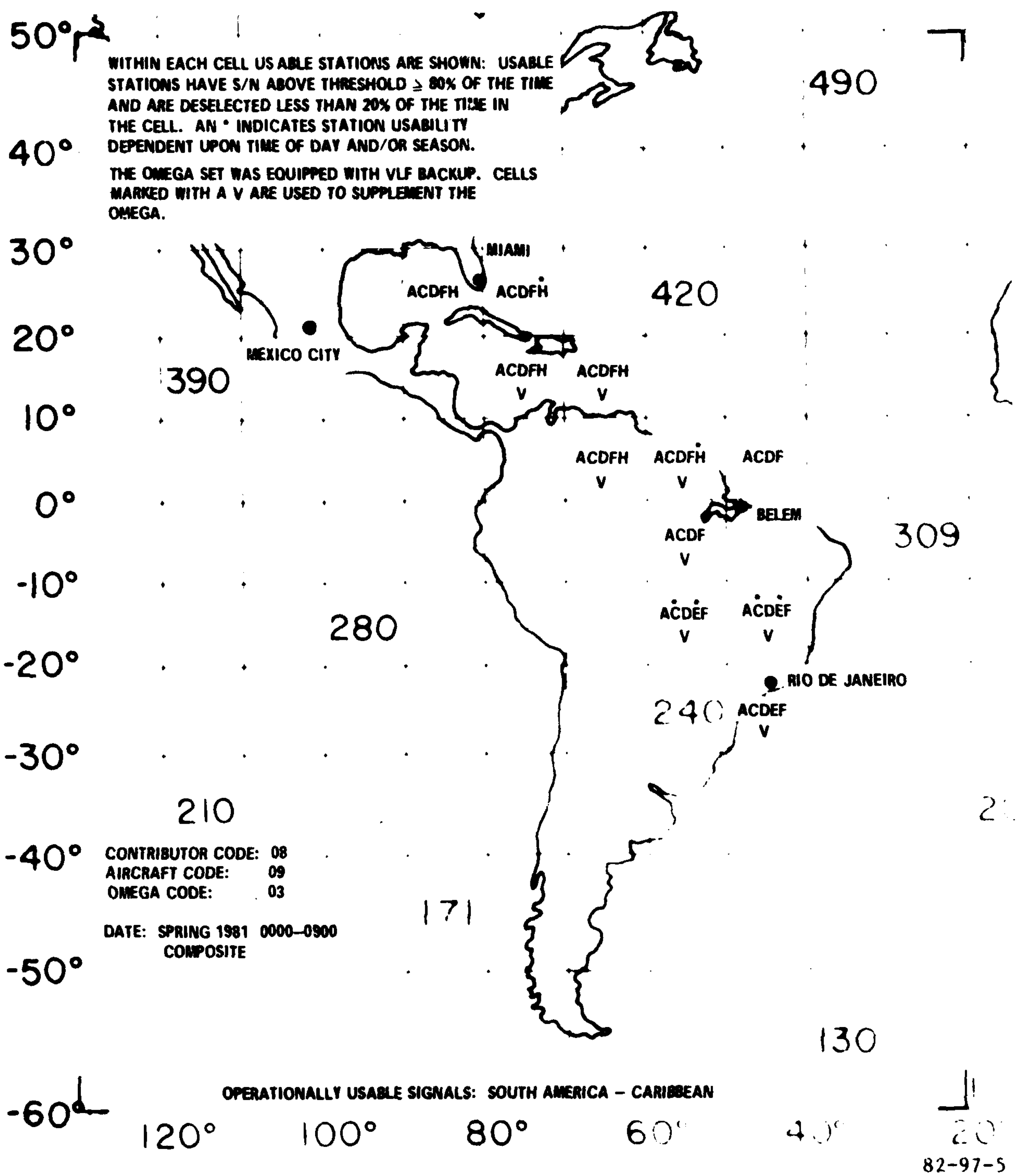

FIGURE 5. OPERATIONALLY USABLE SIGNALS: SOUTH AMERICA-CARIBBEAN, SPRING 1981

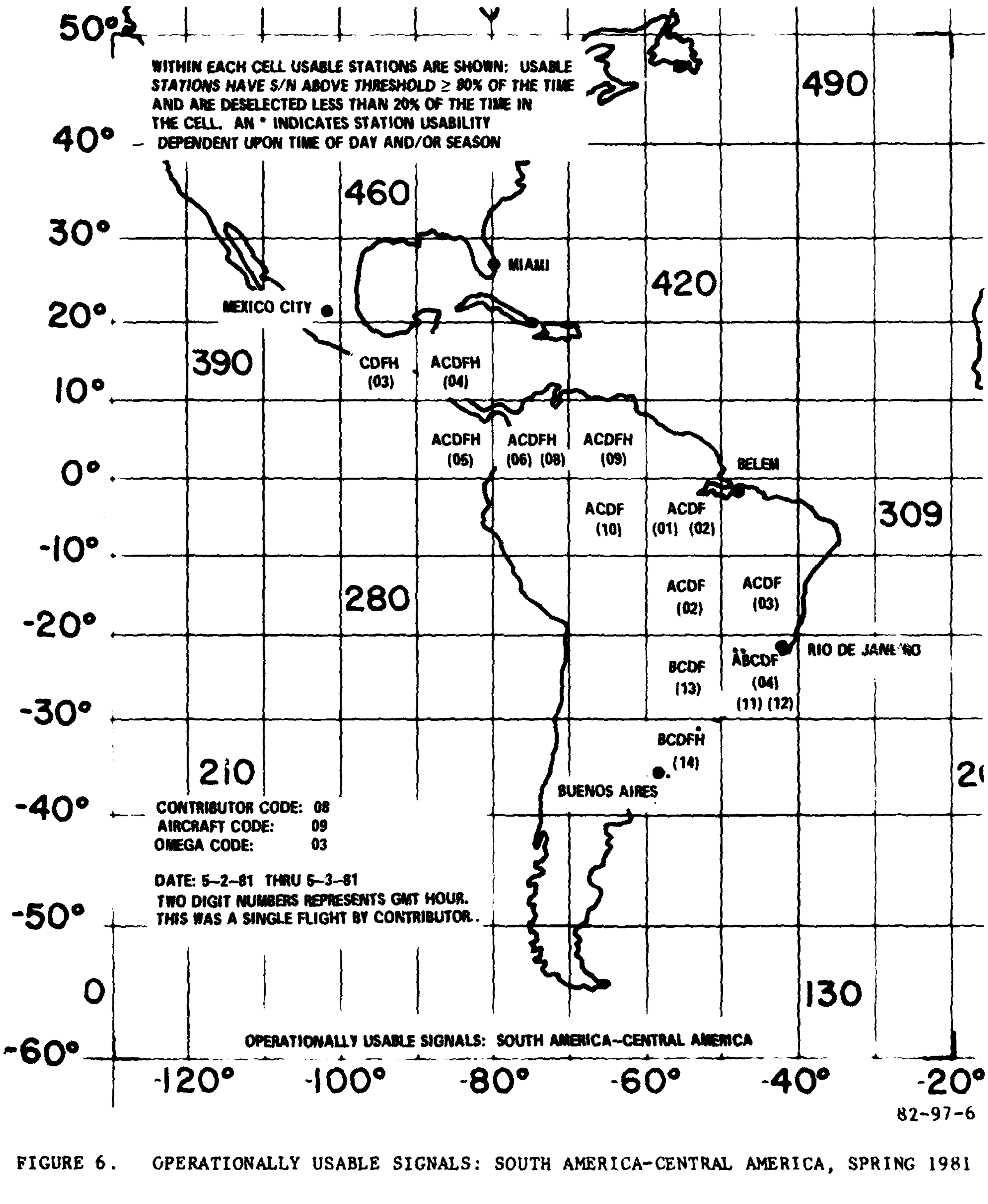

FIGURE 6. OPERATIONALLY USABLE SIGNALS: SOUTH AMERICA-CENTRAL AMERICA, SPRING 1981

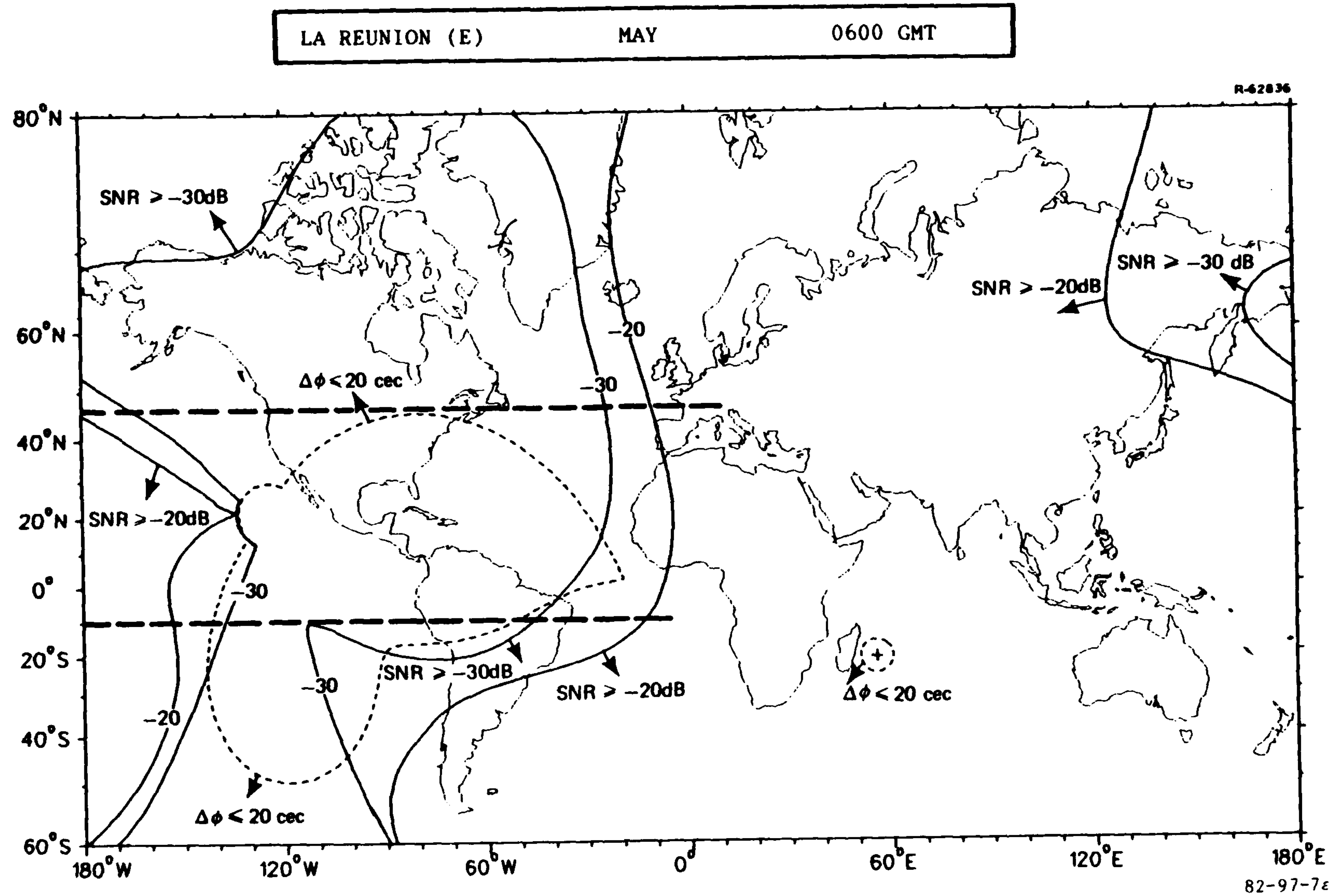

FIGURE 7. OMEGA SIGNAL COVERAGE PREDICTION DIAGRAM LA REUNION (E) (SHEET 1 OF 3)

LA REUNION (E) MAY 1800 GMT

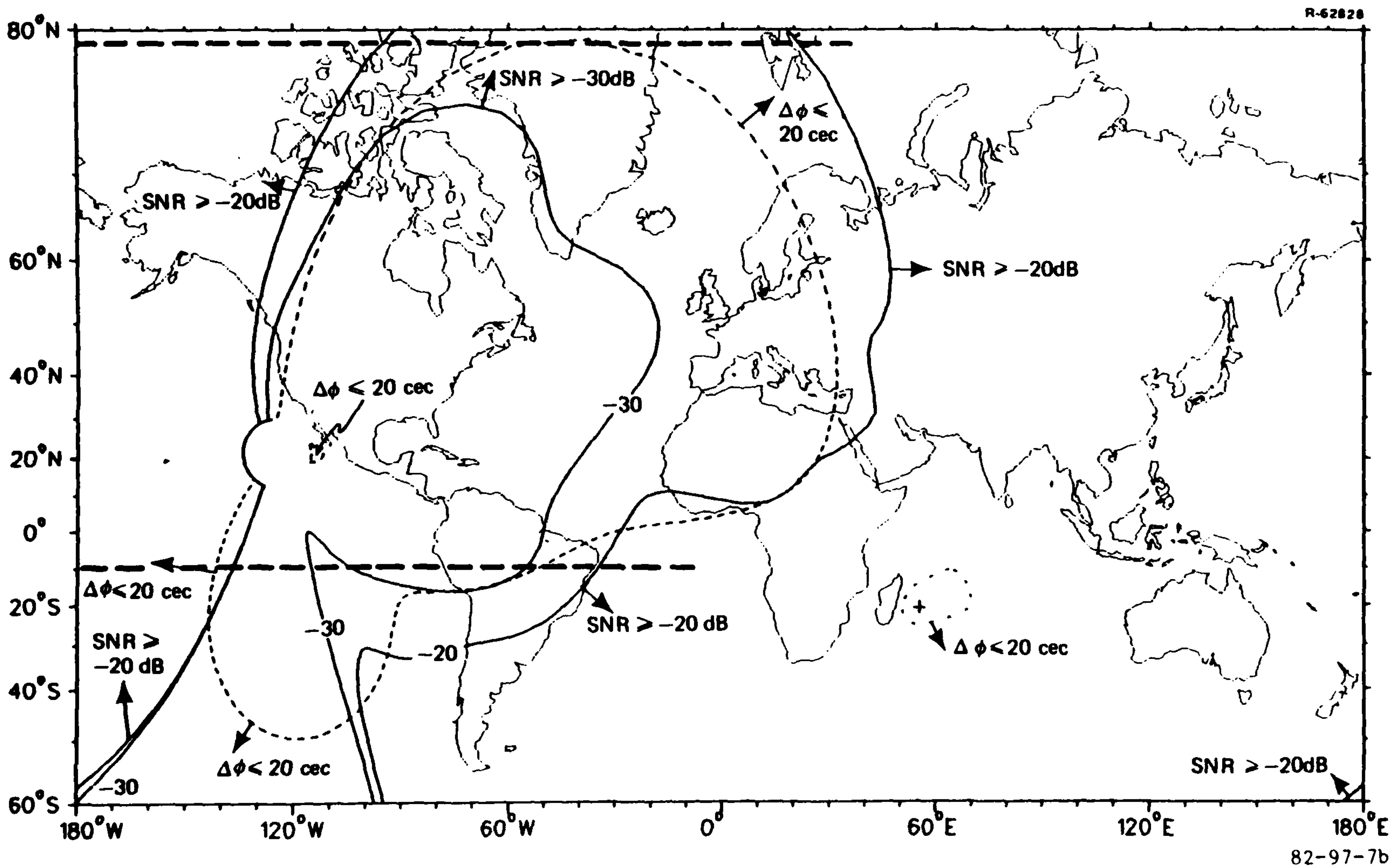

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FIGURE 7. OMEGA SIGNAL COVERAGE PREDICTION DIAGRAM LA REUNION (E) (SHEET 2 OF 3)

LA REUNION (E) FEBRUARY 0600 GMT

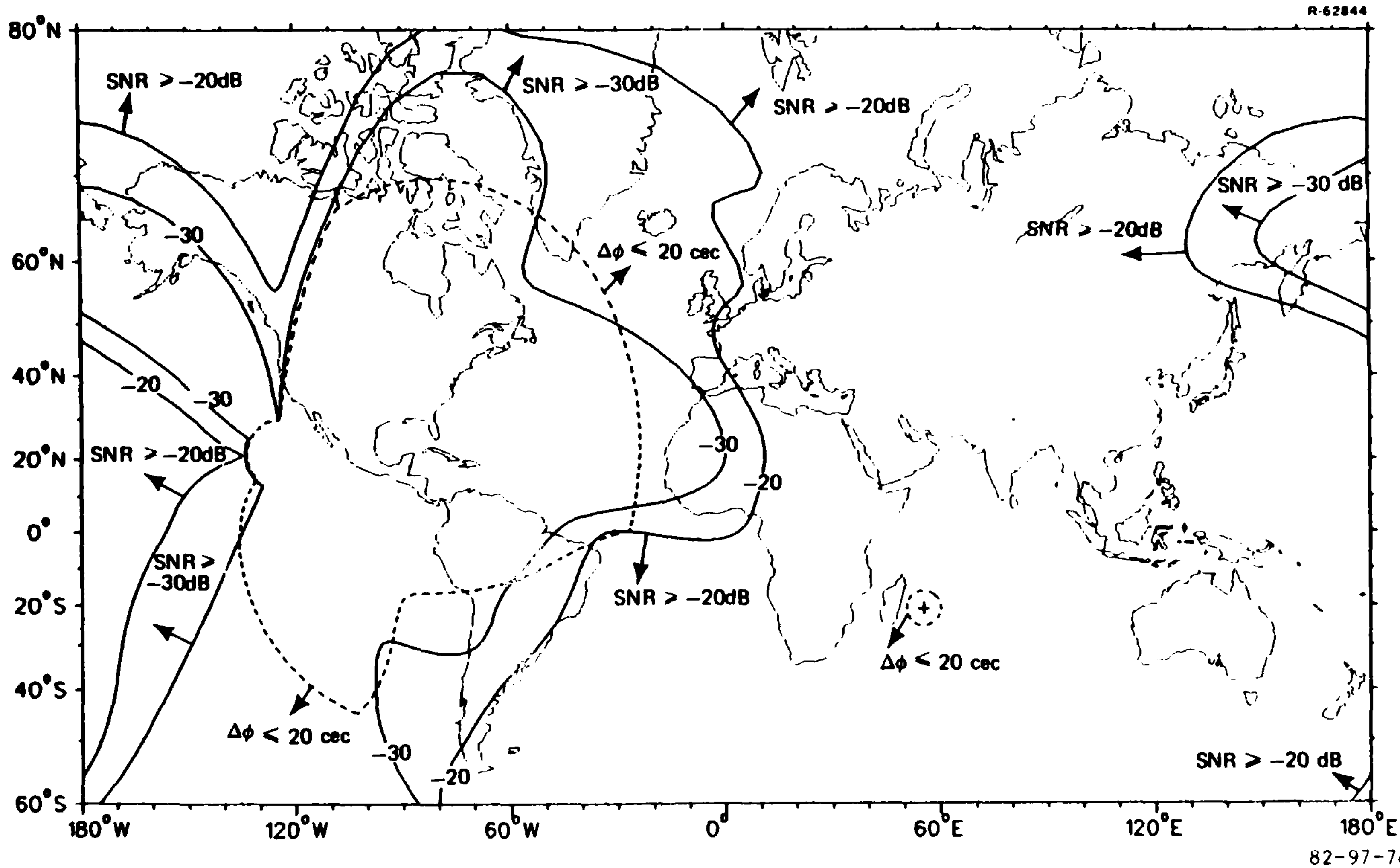


FIGURE 7. OMEGA SIGNAL COVERAGE PREDICTION DIAGRAM LA REUNION (E) (SHEET 3 OF 3)

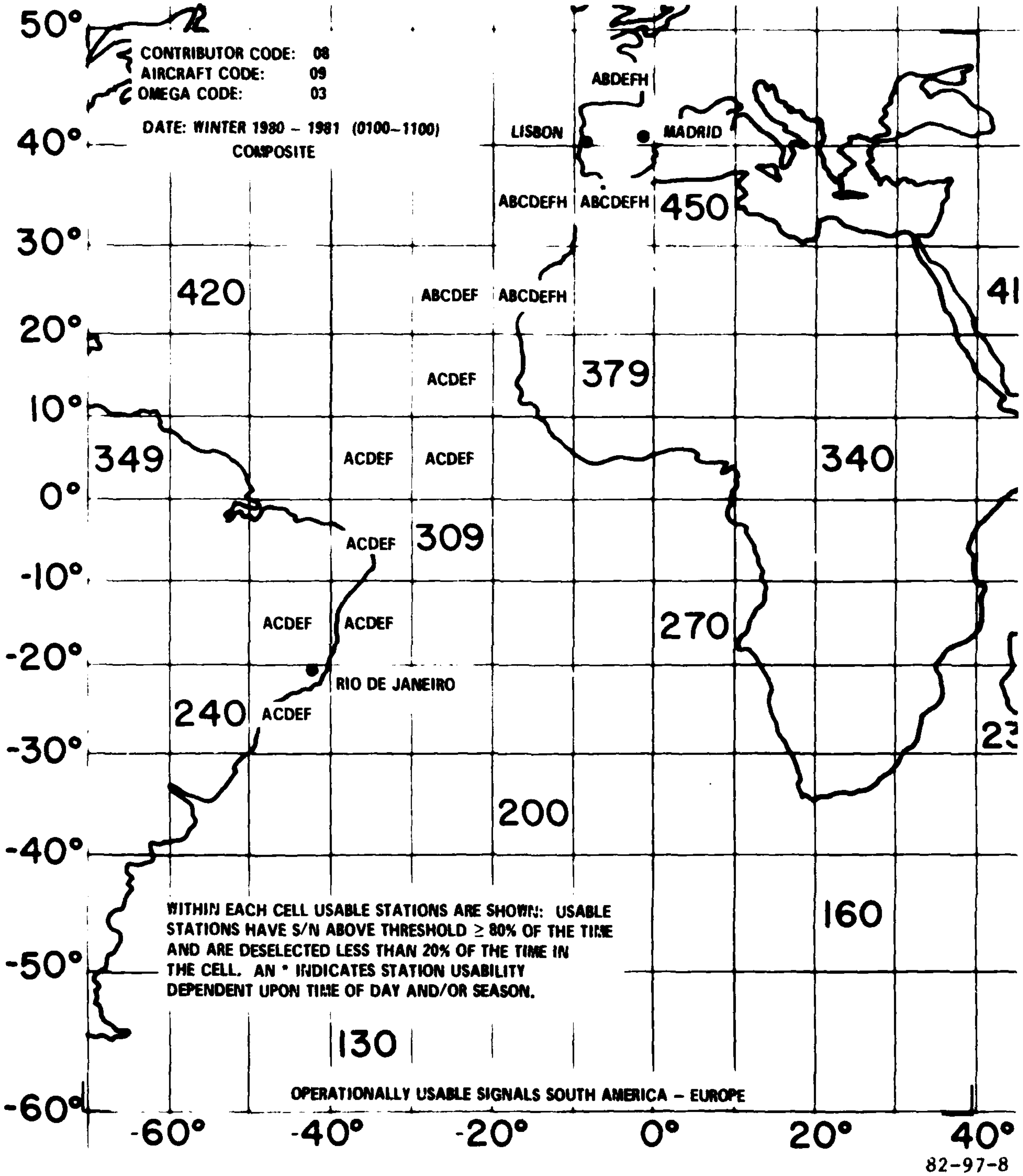


FIGURE 8. OPERATIONALLY USABLE SIGNALS: SOUTH AMERICA-EUROPE, WINTER 1980-1981 (0100-1100 GMT)

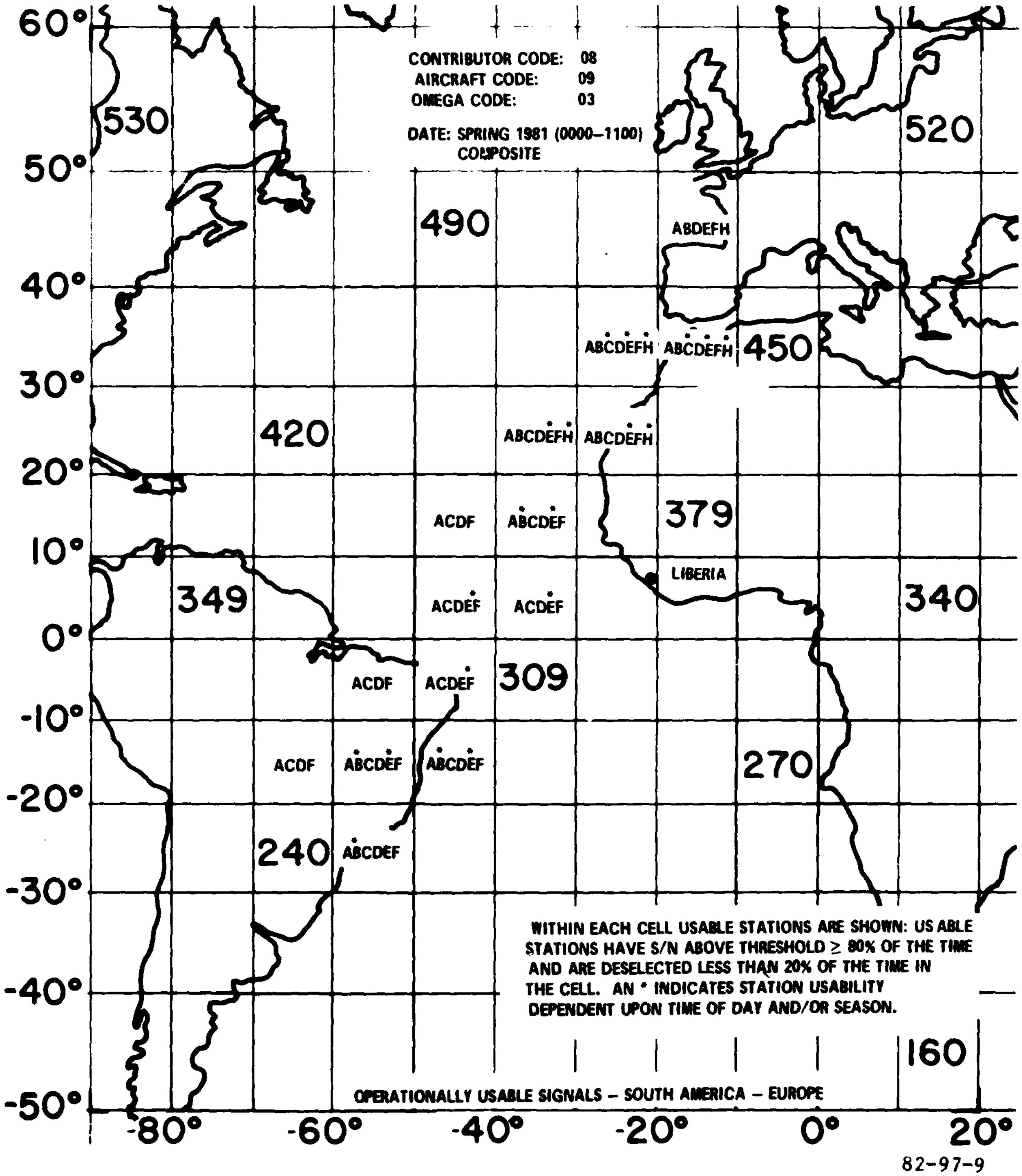


FIGURE 9. OPERATIONALLY USABLE SIGNALS: SOUTH AMERICA-EUROPE, SPRING 1981 (000-0100 GMT)

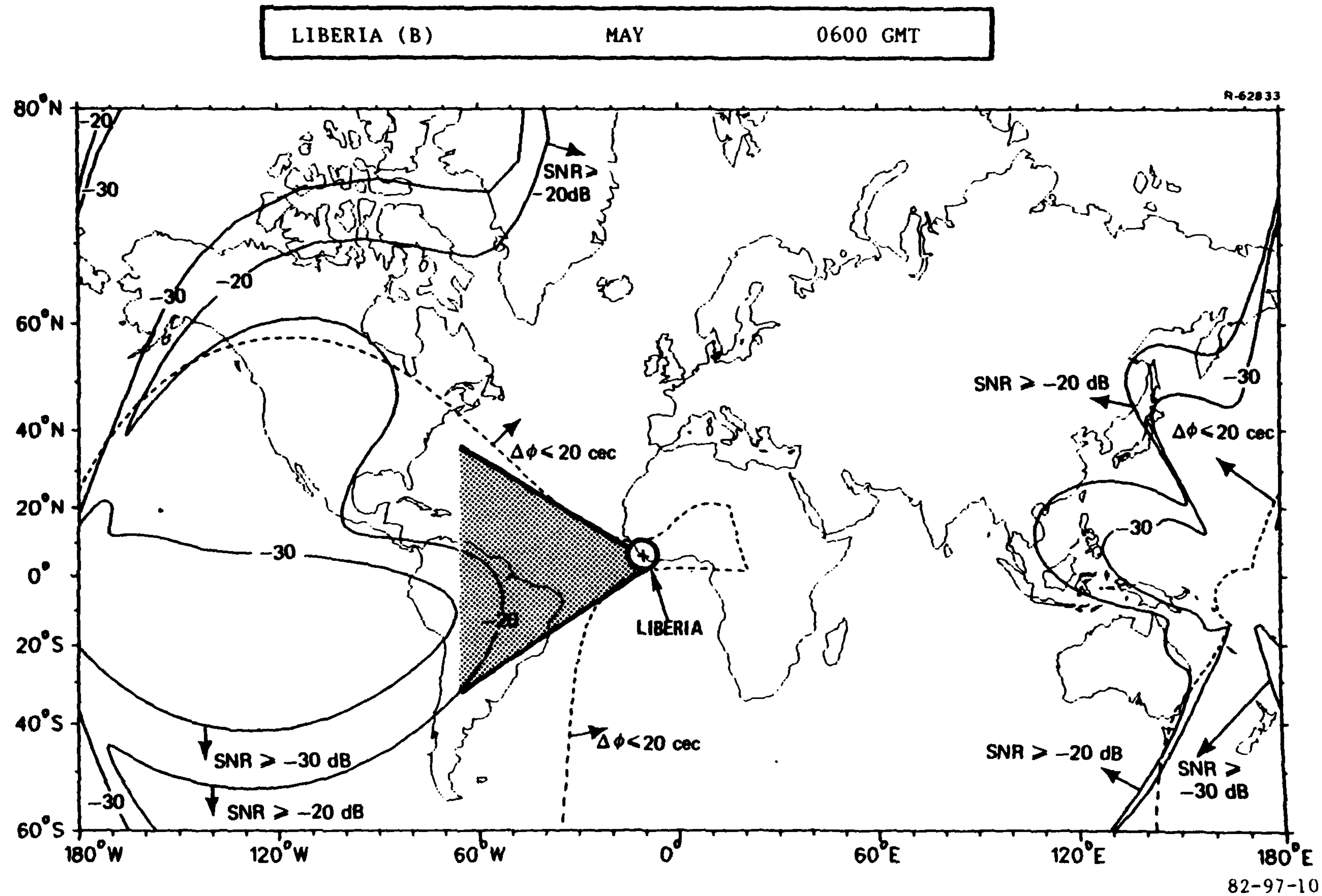


FIGURE 10. OMEGA SIGNAL COVERAGE PREDICTION DIAGRAM LIBERIA (B) (0600 GMT)

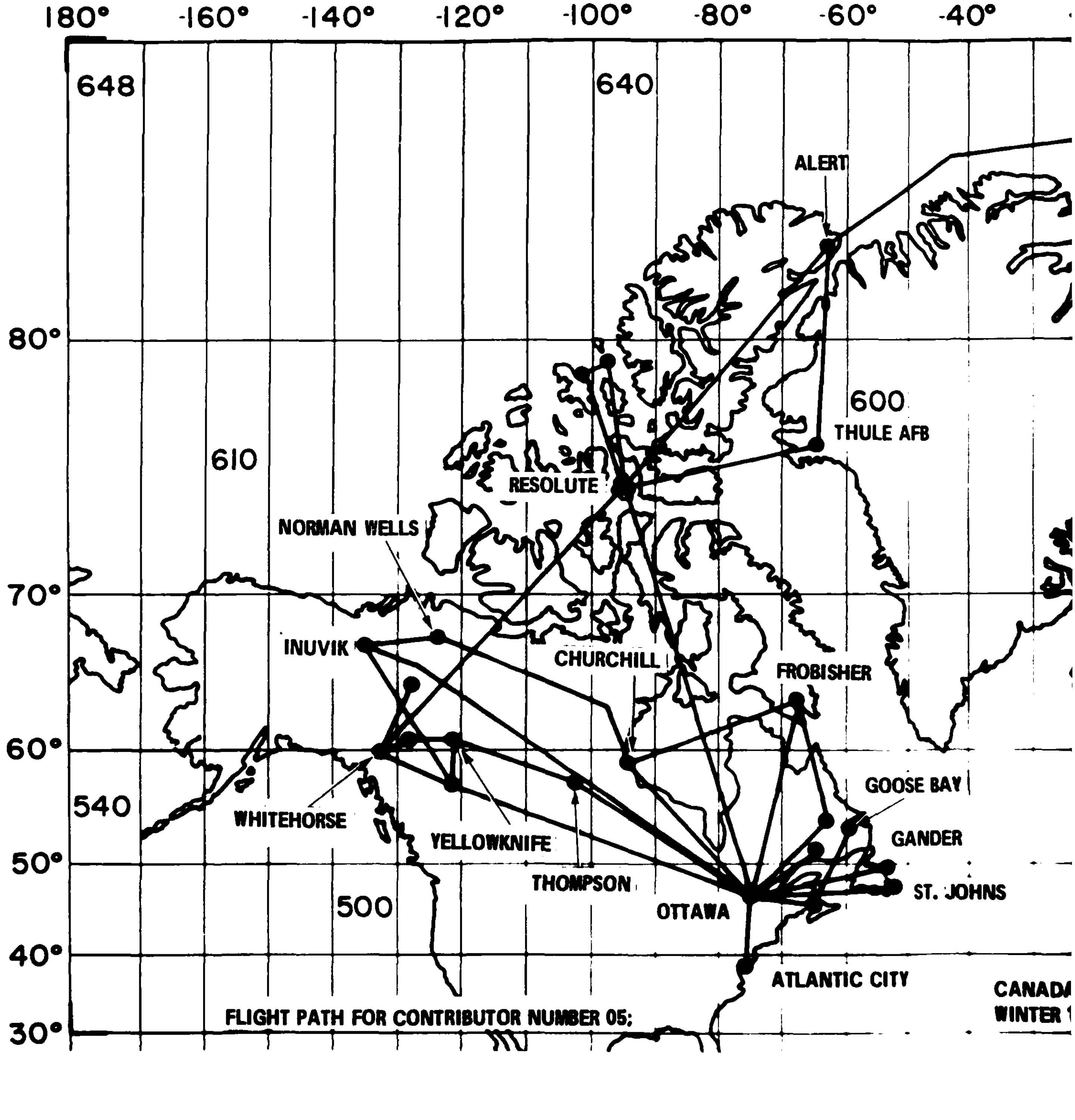
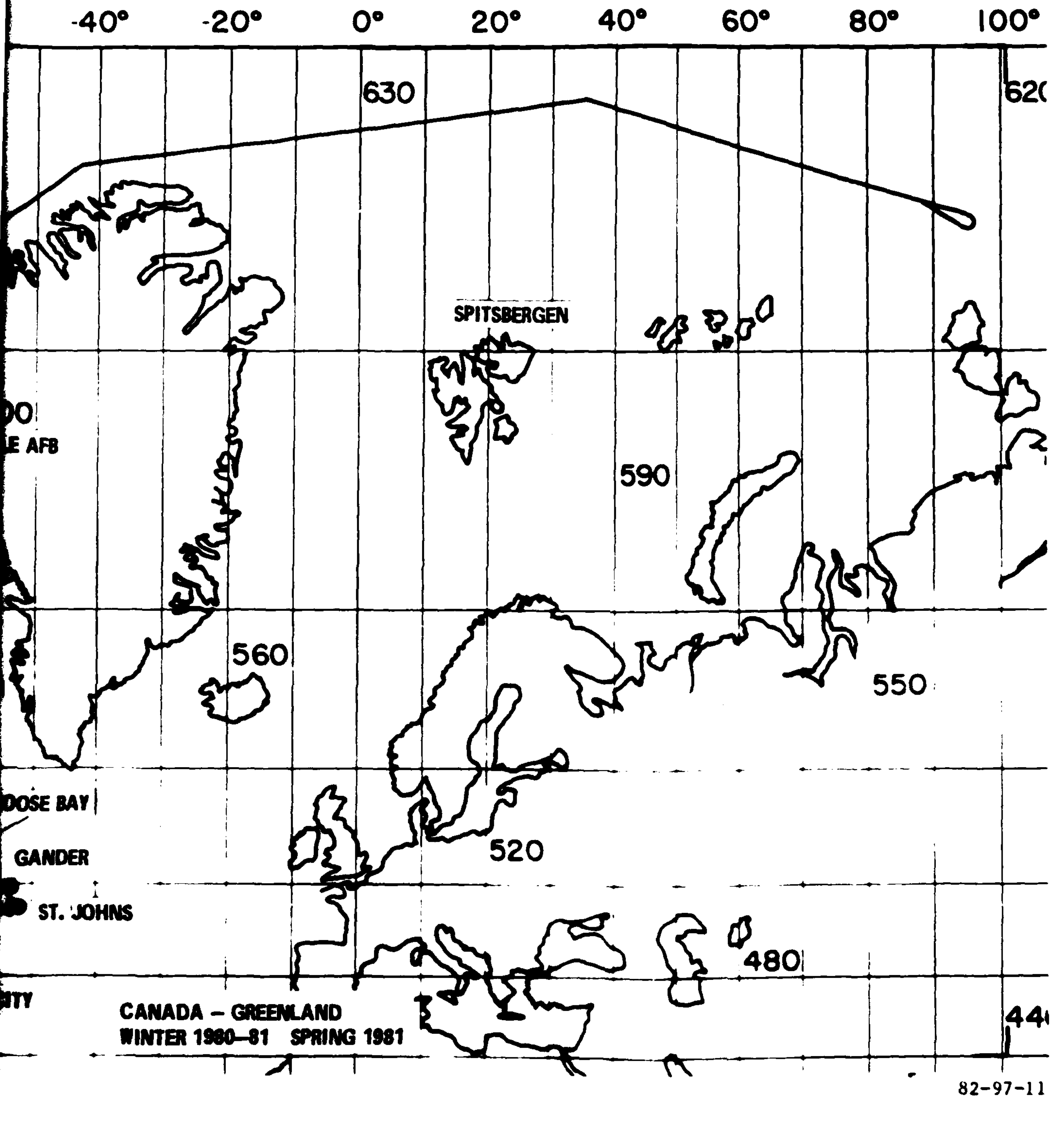


FIGURE 11. FLIGHTPATH FOR CONTRIBUTOR NO. 05,

1



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TRIBUTOR NO. 05, WINTER 1980-1981, SPRING 1981

(2)

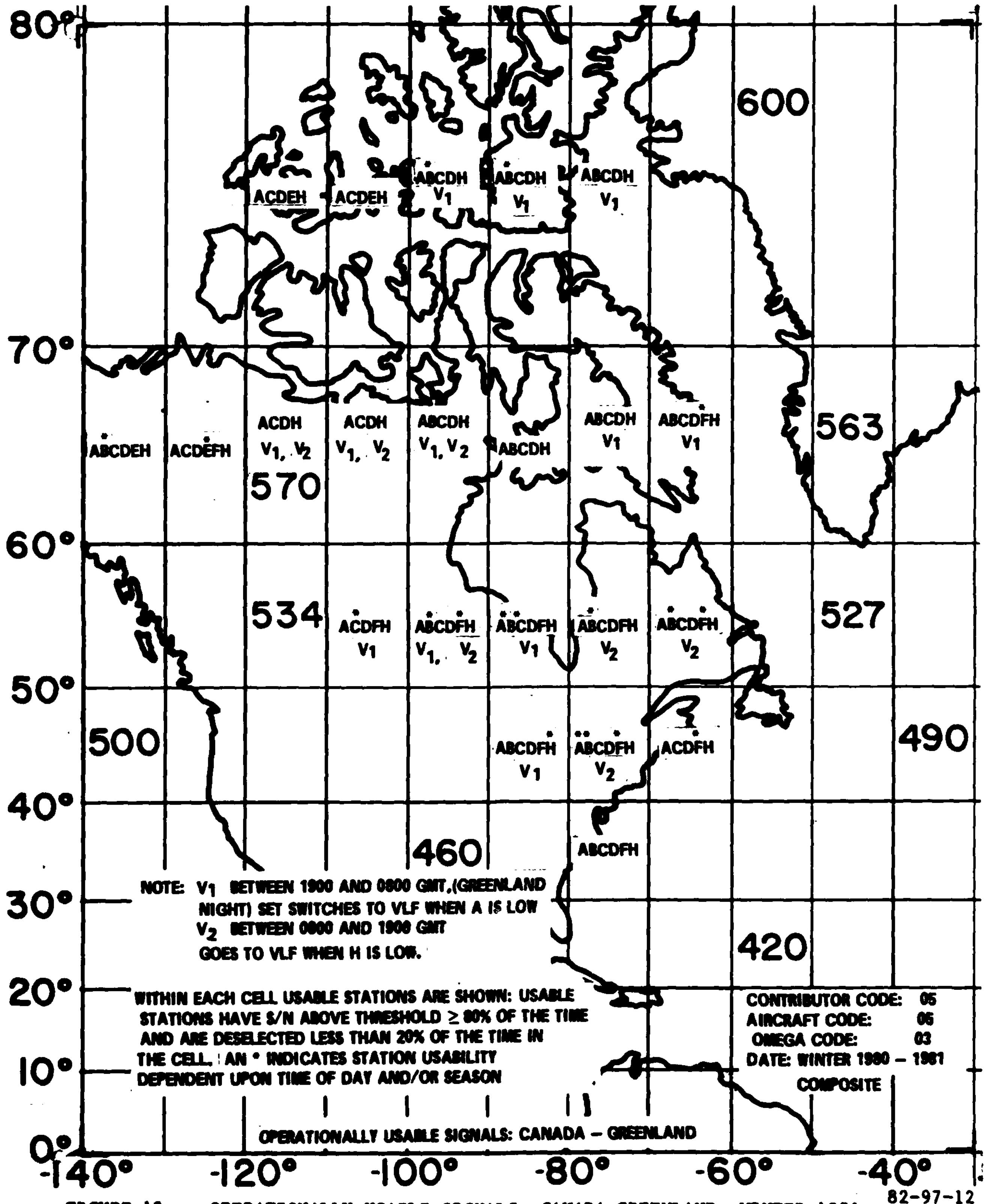

FIGURE 12. OPERATIONALLY USABLE SIGNALS: CANADA-GREENLAND, WINTER 1981

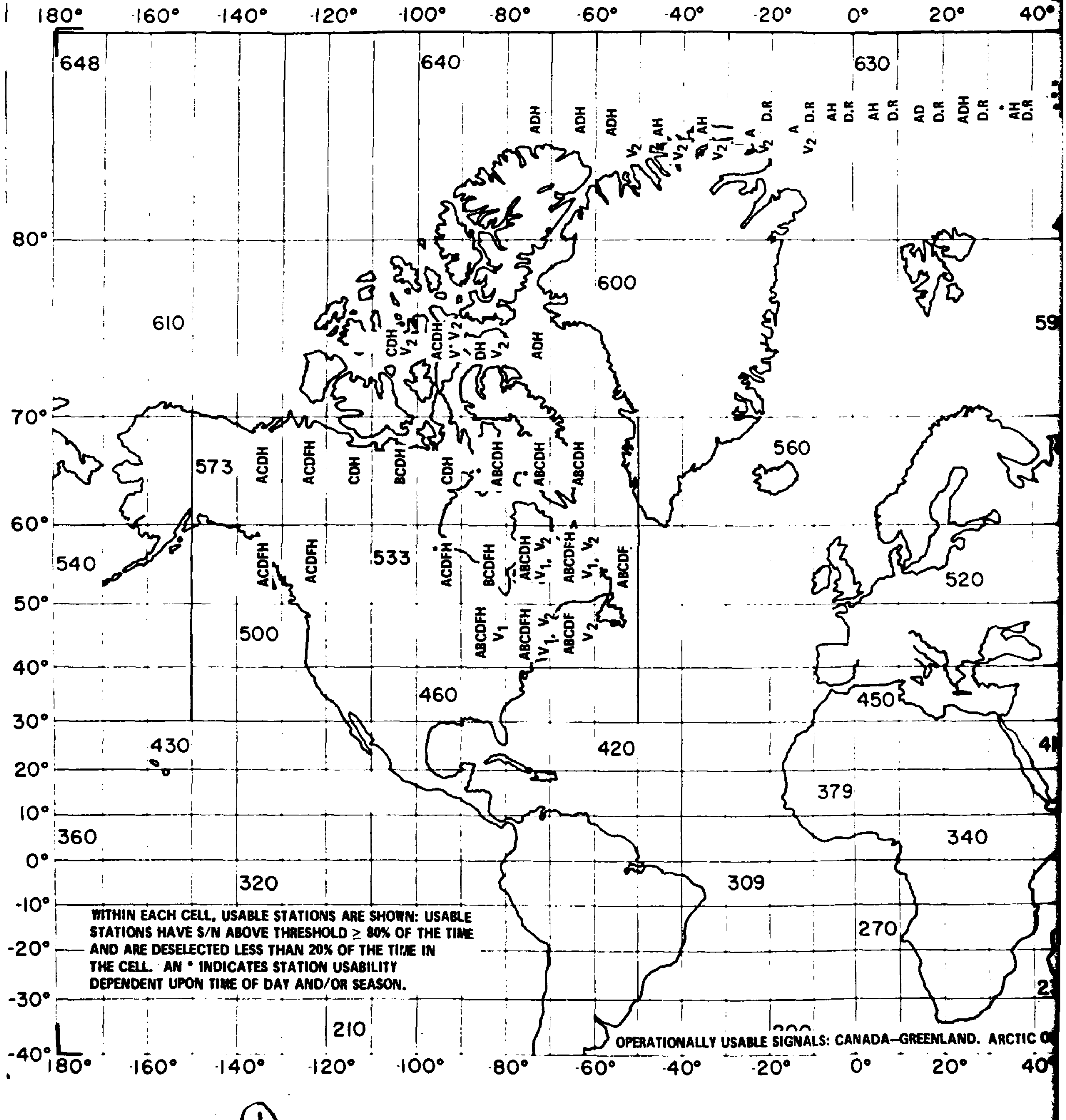

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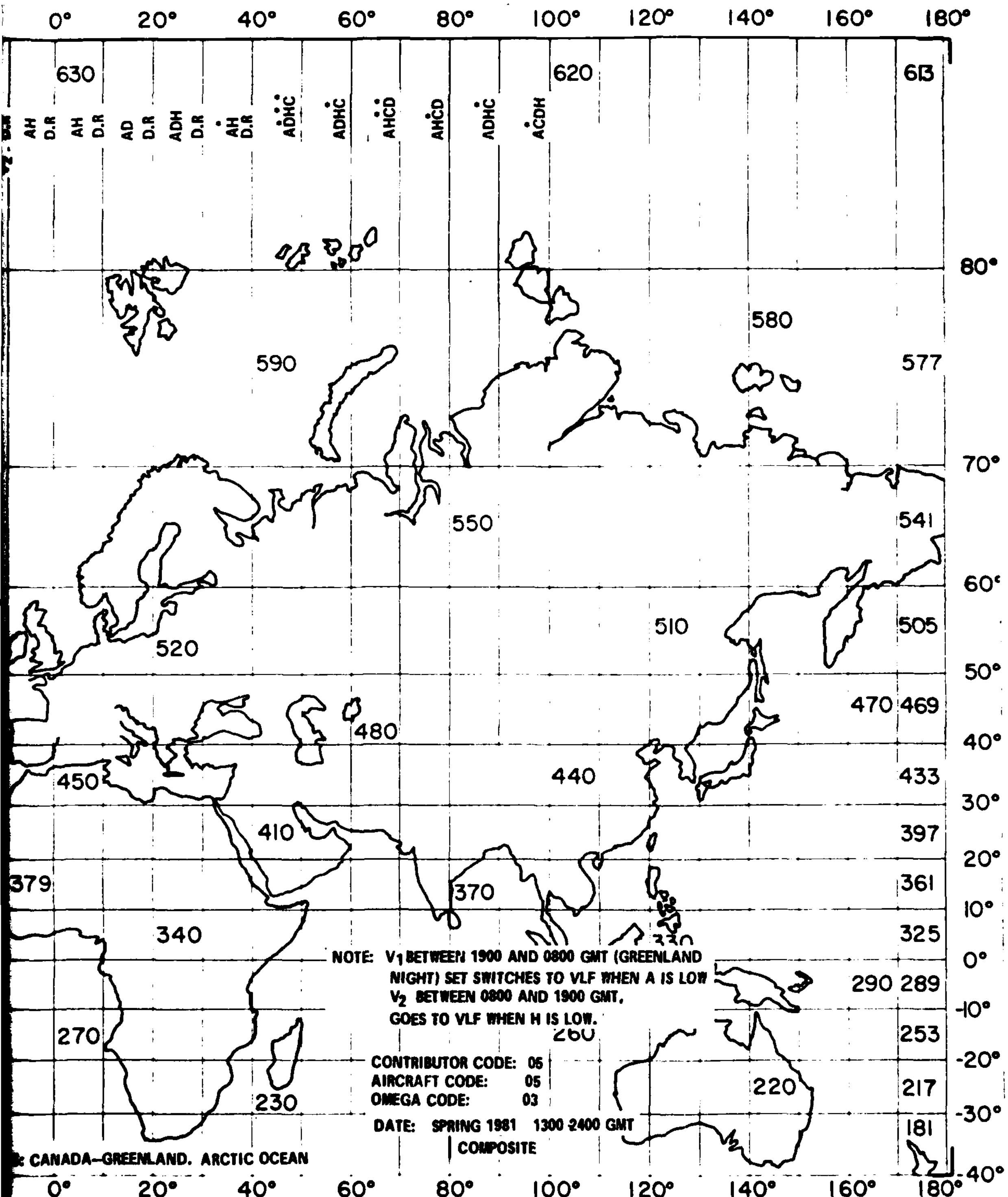
FIGURE 13. OPERATIONALLY USABLE SIGNALS: CANADA-GREENLAND



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ALS: CANADA-GREENLAND-ARTIC OCEAN, SPRING 1981

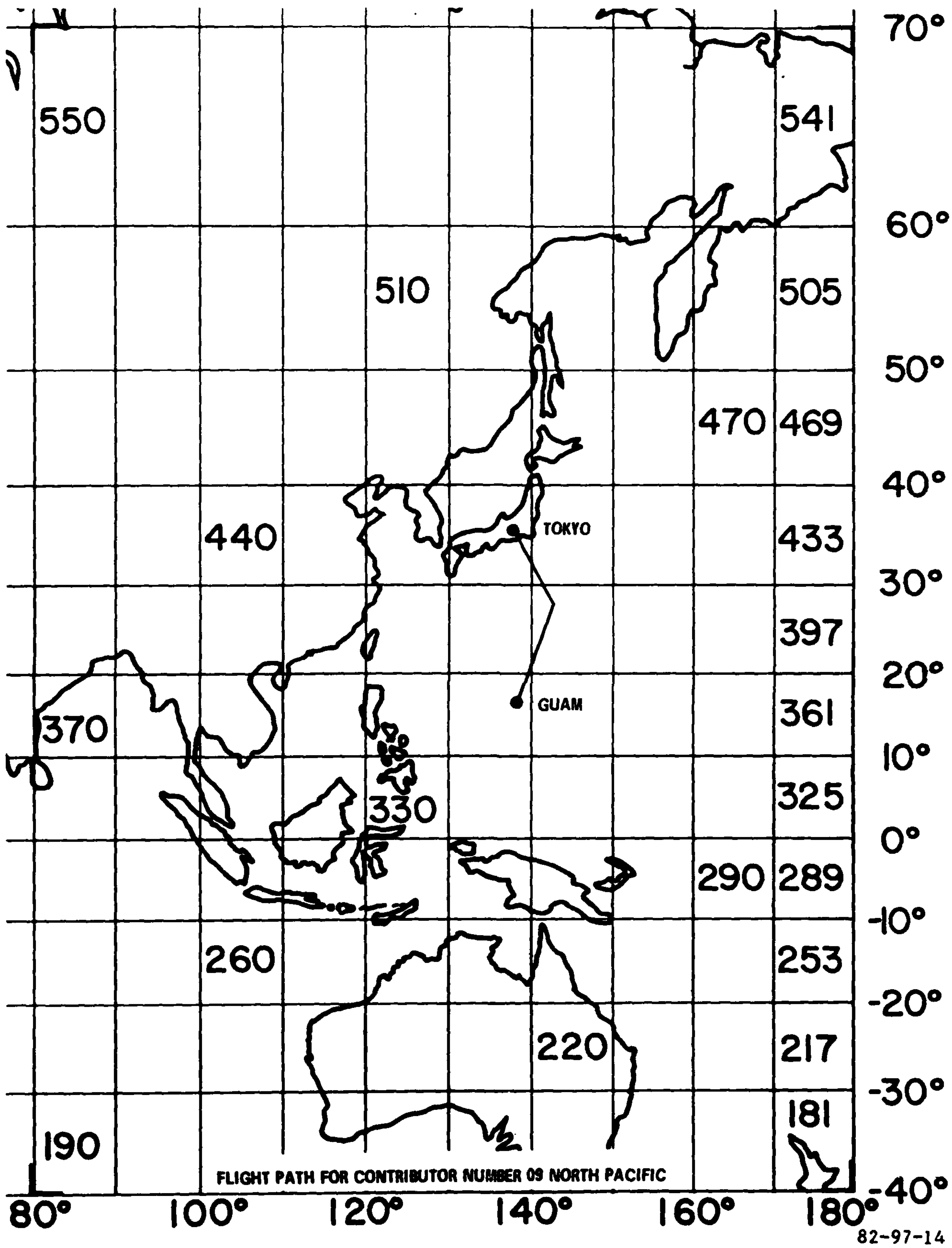

FIGURE 14. FLIGHTPATH FOR CONTRIBUTOR NO. 09, NORTH PACIFIC, SPRING 1981

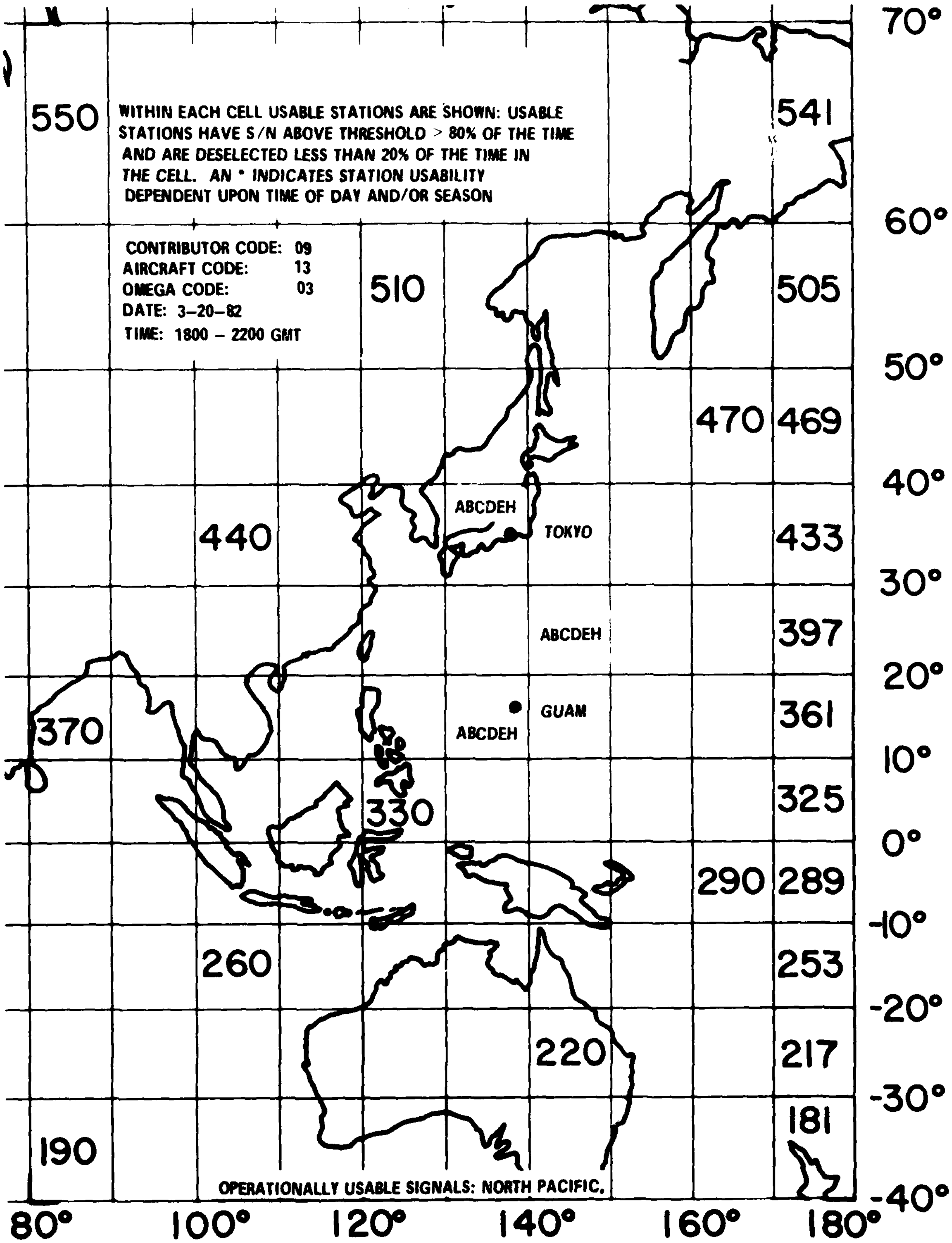

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FIGURE 15. OPERATIONALLY USABLE SIGNALS: NORTH PACIFIC, SPRING 1981

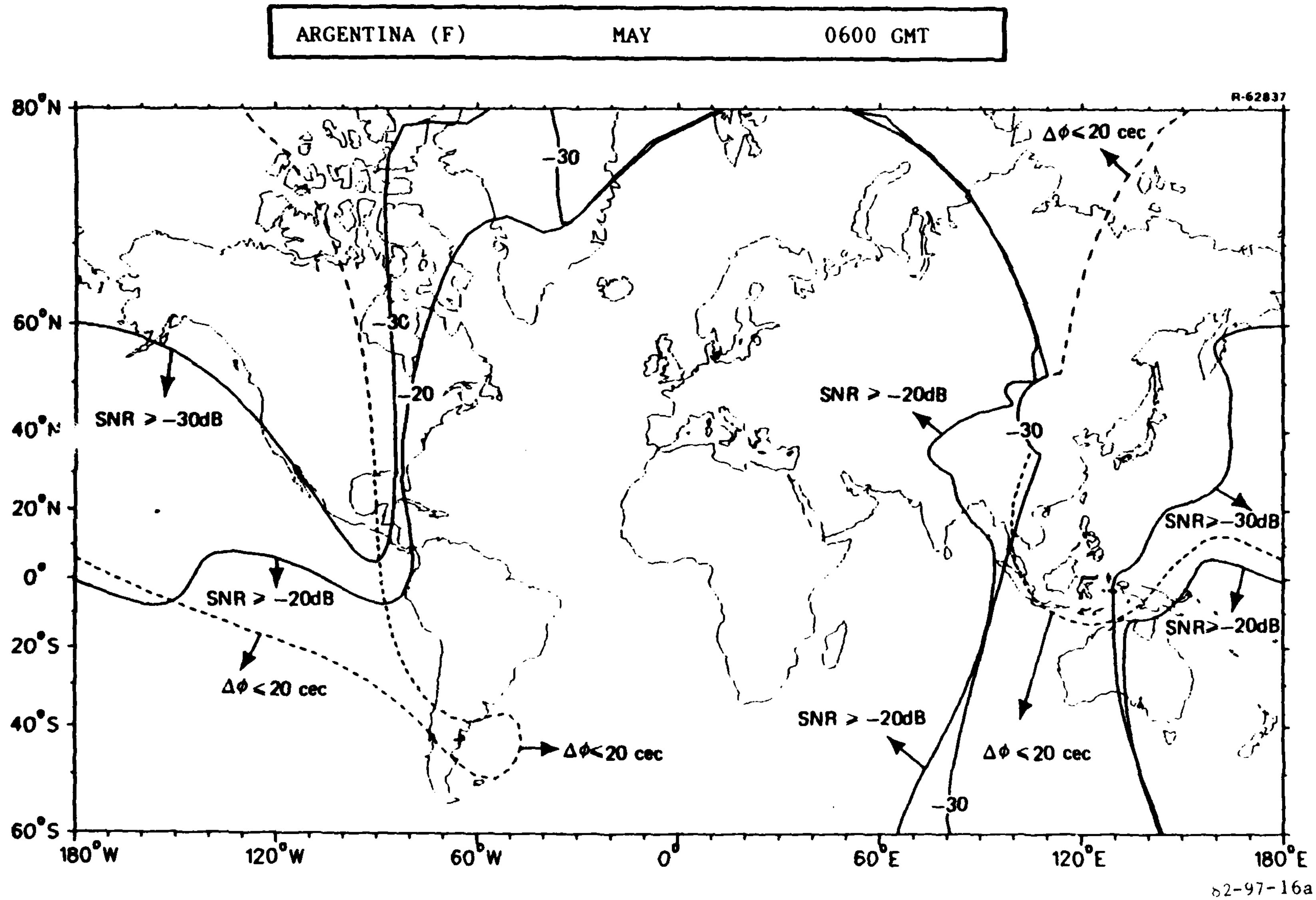

FIGURE 16. OMEGA SIGNAL COVERAGE PREDICTION DIAGRAM ARGENTINA (F) (MAY 0600 - 1800 GMT) (SHEET 1 OF 2)

ARGENTINA (F) MAY 1800 GMT

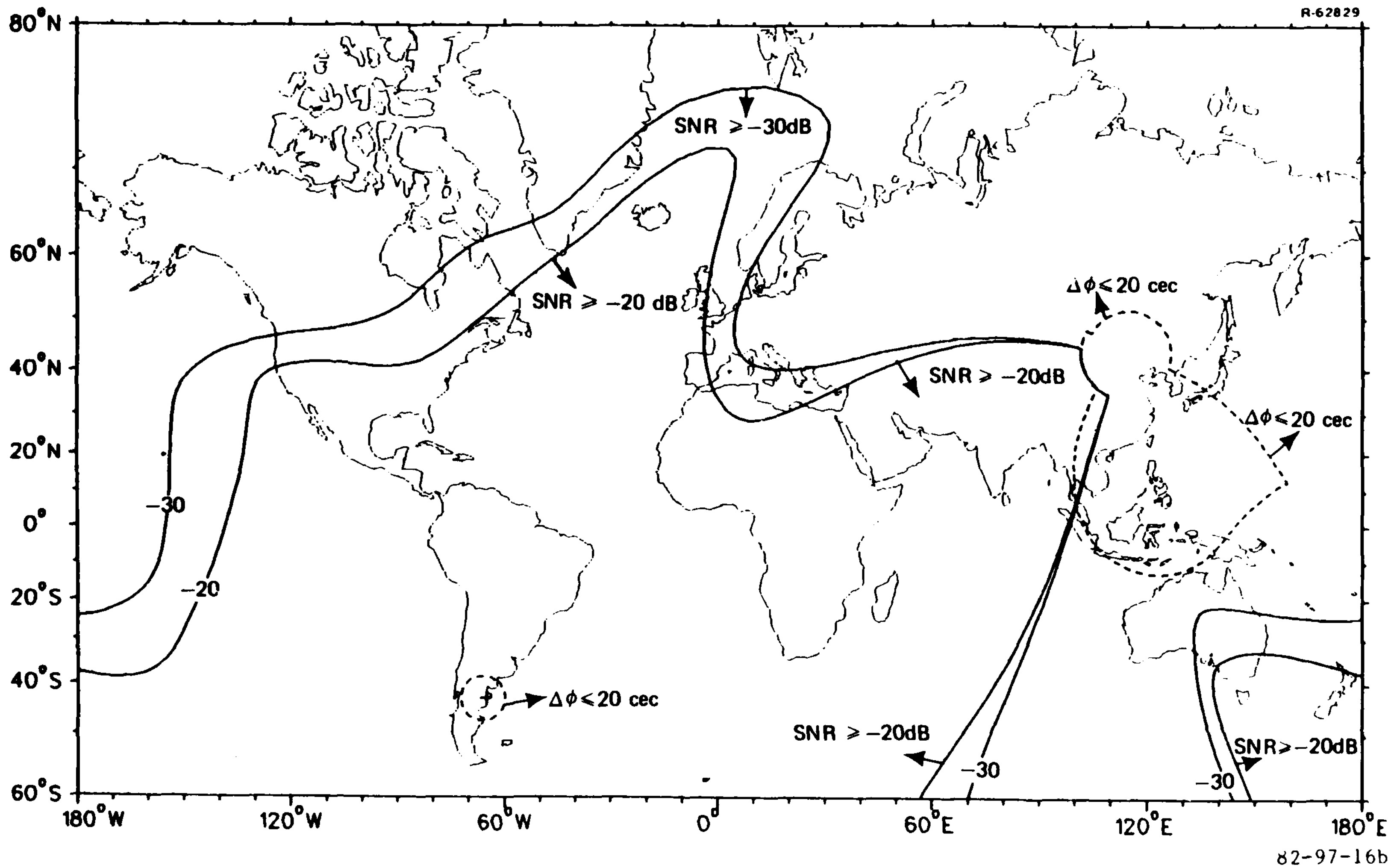

FIGURE 16. OMEGA SIGNAL COVERAGE PREDICTION DIAGRAM ARGENTINA (F) (MAY 0600 - 1800 GMT) (SHEET 2 OF 2)

GMT H	GMT M	LAT D	LAT M	LONG D	LONG M	SIGNAL TO NOISE NO. 0-9 10.2	13.6	11.3	TRK DEG	DSR TRK	MAG HDG	ASP KTS	GSP KTS	WSP KTS	WDIR DEG	XTRK NMI	WP-DST NMI	USABLE STATIONS	VLF STATIONS
19	19	21	57	142	45	98338409*	99449509*	98439109*	347	347	345	474	462	33	278	-0.3	188.0	ABCDE--H	
19	20	22	5	142	44	98339409*	99349509*	98449409*	347	347	345	474	465	30	274	-0.3	180.0	ABCDE--H	
19	21	22	12	142	42	97349419*	88449609*	99439519*	347	347	343	477	468	33	273	-0.3	172.0	ABCDE--H	
19	22	22	20	142	40	88339409*	99539619*	99439419*	347	347	345	477	468	33	271	-0.2	165.0	ABCDE--H	
19	23	22	27	142	39	98339409*	99539509*	98439409*	347	347	343	480	468	36	274	-0.3	157.0	ABCDE--H	
19	24	22	35	142	37	98239419*	98639509*	99448409*	346	346	343	480	468	36	273	-0.3	149.0	ABCDE--H	
19	25	22	43	142	35	98239209*	98549309*	98449409*	346	346	343	480	468	36	270	-0.3	141.0	ABCDE--H	
19	26	22	50	142	33	98239309*	98549509*	98439509*	347	347	343	480	471	39	269	-0.2	133.0	ABCDE--H	
19	27	22	58	142	32	98339319*	99549609*	97339409*	346	346	343	480	468	39	270	-0.2	125.0	ABCDE--H	
19	28	23	6	142	29	98328319*	99539609*	98449509*	346	346	343	480	471	42	267	-0.3	118.0	ABCDE--H	
19	29	23	13	142	28	98239409*	99549609*	98449409*	346	346	343	477	468	42	266	-0.2	110.0	ABCDE--H	
19	30	23	21	142	26	98239409*	99639609*	98339419*	347	347	343	477	468	45	266	-0.2	102.0	ABCDE--H	
19	31	23	29	142	24	98349409*	99639619*	98339509*	347	347	343	477	468	45	266	-0.2	94.0	ABCDE--H	
19	32	23	36	142	22	98339509*	98549509*	98339409*	346	346	343	477	468	45	266	-0.2	86.0	ABCDE--H	
19	33	23	44	142	20	98339509*	99539509*	98339409*	347	347	343	477	468	45	264	-0.3	78.0	ABCDE--H	
19	34	23	52	142	19	98339509*	99559509*	98439409*	346	346	342	477	468	48	266	-0.2	71.0	ABCDE--H	
19	35	23	59	142	17	98429519*	99649619*	98439509*	347	347	343	480	471	48	263	-0.2	63.0	ABCDE--H	
19	36	24	7	142	15	88439009*	98539609*	98339419*	347	347	343	474	471	48	260	-0.1	55.0	ABCDE--H	
19	37	24	15	142	13	98428209*	98539509*	98439409*	347	347	342	477	471	45	257	-0.2	47.0	ABCDE--H	
19	38	24	23	142	11	88439419*	98549609*	98339509*	347	347	343	477	477	45	256	-0.3	39.0	ABCDE--H	
19	39	24	31	142	9	99439509*	98459619*	98349509*	346	346	343	477	477	45	256	-0.4	31.0	ABCDE--H	
19	40	24	39	142	7	88438409*	99509509*	97439409*	346	346	342	477	480	48	252	-0.5	23.0	ABCDE--H	
19	41	24	47	142	5	97309509*	88439709*	97438509*	347	347	343	477	480	51	252	-0.4	15.0	ABCDE--H	
19	42	24	54	142	3	98439409*	98449519*	97439509*	347	347	343	477	477	51	253	-0.4	7.0	ABCDE--H	
19	43	25	2	142	1	88049409*	98548509*	97439519*	347	347	345	474	477	51	253	-0.6	304.0	ABCDE--H	
19	44	25	10	142	0	98319309*	99549509*	97438609*	352	354	347	474	483	54	249	-0.4	295.0	ABCDE--H	
19	45	25	18	141	58	97239409*	88549509*	98438509*	350	352	346	474	483	51	249	0.	288.0	ABCDE--H	
19	46	25	26	141	57	98339519*	99539409*	97429509*	350	350	346	477	486	54	246	0.	280.0	ABCDE--H	
19	47	25	34	141	55	98439409*	88439409*	98439509*	350	350	346	474	483	54	246	0.1	272.0	ABCDE--H	
19	48	25	42	141	54	97348409*	99439509*	97439509*	350	350	346	471	483	54	248	0.2	264.0	ABCDE--H	
19	49	25	50	141	53	98349419*	88549609*	98438419*	350	350	346	471	480	54	248	0.3	255.0	ABCDE--H	
19	50	25	58	141	51	98439309*	87449609*	97449409*	350	352	346	474	483	54	246	0.5	247.0	ABCDE--H	
19	51	26	6	141	50	98339319*	98439609*	97349209*	350	352	346	474	486	57	246	0.7	239.0	ABCDE--H	
19	52	26	14	141	48	98449209*	98539609*	98539509*	350	350	346	474	483	54	246	1.0	231.0	ABCDE--H	
19	53	26	22	141	46	97439309*	88549619*	97449309*	349	349	345	471	483	57	245	1.0	223.0	ABCDE--H	
19	54	26	30	141	45	97439209*	98549509*	97448319*	349	349	345	471	483	57	245	0.9	215.0	ABCDE--H	
19	55	26	38	141	43	98349309*	98538509*	97339409*	350	350	346	474	483	57	245	0.9	207.0	ABCDE--H	
19	56	26	45	141	41	98339109*	97549609*	97449409*	350	350	346	474	483	57	249	1.0	199.0	ABCDE--H	
19	57	26	53	141	40	87139419*	87539409*	97348309*	350	350	345	474	483	57	248	1.0	191.0	ABCDE--H	
19	58	27	1	141	38	98339309*	97548409*	87338509*	349	349	345	474	480	57	249	1.0	183.0	ABCDE--H	
19	59	27	9	141	36	98419409*	98449509*	96339409*	349	349	345	471	480	57	246	1.0	175.0	ABCDE--H	
20	0	27	17	141	34	98419409*	98439419*	9733950**	349	349	345	471	480	57	245	1.0	167.0	ABCDE--H	
20	1	27	25	141	32	98449509*	98449409*	97449609*	349	349	345	468	480	57	243	0.9	159.0	ABCDE--H	
20	2	27	33	141	31	98519409*	98449509*	97439509*	349	349	345	471	483	57	242	0.8	151.0	ABCDE--H	
20	3	27	41	141	29	98439409*	99549509*	98439519*	347	347	343	471	483	57	240	0.7	142.0	ABCDE--H	
20	4	27	49	141	27	98539409*	99638609*	97439509*	347	347	343	471	483	57	242	0.6	135.0	ABCDE--H	
20	5	27	57	141	26	98449409*	99649609*	97539519*	347	347	343	474	486	63	243	0.6	126.0	ABCDE--H	
20	6	28	5	141	24	98439109*	98539619*	98549109*	347	347	343	474	486	63	243	0.6	118.0	ABCDE--H	
20	7	28	12	141	22	99439409*	99549519*	98539509*	347	347	343	474	483	66	246	0.6	110.0	ABCDE--H	

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FIGURE 17. SAMPLE PRINTOUT OF CONTRIBUTOR NO. 09 SNR LEVELS RECORDED IN CELL NO. 400: NORTH PACIFIC, SPRING 1981

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